EFFECT OF WASTE DISPOSAL ON WATER QUALITY IN PARTS OF COCHIN-KERALA

DISSERTATION

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By

ABDUL BASHEER V. VILAKIRI

Under the Supervision of

Dr. SHADAB KHURSHID

READER

DEPARTMENT OF GEOLOGY
ALIGARH MUSLIM UNIVERSITY
ALIGARH (INDIA)

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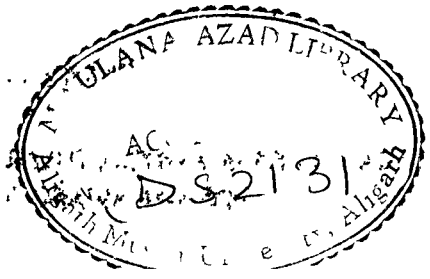
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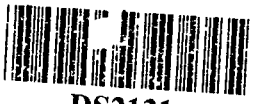
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TO

MY DEPARTED
FATHER AND AUNT

Dr. Shadab Khurshid
Reader & Deputy Co-ordinator
(DSA Programme)

Phones {Off. (0571) 25615
Res. (0571) 25979
Telex : 564-230-AMU-IN

ENVIRON/HYDRO LAB
DEPARTMENT OF GEOLOGY
Aligarh Muslim University
Aligarh-202002 (INDIA)

C E R T I F I C A T E

This is to certify that the dissertation entitled "EFFECT OF WASTE DISPOSAL ON WATER QUALITY IN PARTS OF COCHIN - KERALA" is an original contribution of Mr. ABDUL BASHEER. V. VILAKIRI in ENVIRONMENTAL GEOLOGY which has carried out under my supervision. It has not been published in parts or full anywhere else.

Mr. Basheer is allowed to submit this work for the award of M.Phil. Degree of Aligarh Muslim University, Aligarh.

S Khurshid

(Dr. SHADAB KHURSHID)

SUPERVISOR

A C K N O W L E D G E M E N T

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(ABDUL BASHEER)

C O N T E N T S

INTRODUCTION

CHAPTER - I

INTRODUCTION

The intesity of man's activities and diversity and magnitude of different types of wastes introduced into environment as a consequence, are increasing at an alarming rate. Environmental pollution has become a problem of major consequeces. They have come into sharp focus in the past decade or so. Discharge of waste products create a significant impact on environment and affect all living creatures. Hence environmental pollution includes the release of susbstance which harms the quality of air, water, soil, and which upsets the biological cycles linking man to animal, bacteria and plants. It also includes the substances which is hazardous to man and other organisms.

Environmental pollution is generally referred to man-made Pollution and is the introduction directly or indirectly through man's activities into the atmosphere hydrosphere, lithosphere and biosphere which may affect the environments of biosphere. Environmental pollution are largely associated with various human problems such as maintenance of renewabale resources, geological hazards associated with many natural disasters as earth

quakes, volcanic erruptions, floods, landslides, conservation of non renewable resources, alleviate chronic droughts, indiscriminate consumption of fertilizers, pesticides, herbicides, insecticides in agriculture, sewage and industrial effluents and natural pollutional hazards.

The word pollution can be defined as the occurance of substance in wrong places at wrong times in wrong amounts. But it, is not easy to give a precise definition of "Pollution" or the word polluting. Most people have fairly definite view to what constitutes pollution in a stream. If a river is turbid or coloured or contains visible suspended or floating matter or has an objectionable smell, then it is rightly regarded by an average person as polluted. In other words the presence of harmful substances or organisms that cause disease or discomfort to human being is said to be pollution.

Types of Environmental Pollution

The environmental pollution has been classified into the following types.

I Air pollution

II Water pollution

III Solid waste pollution

IV Noise pollution

V Thermal Pollution

VI Radin active pollution.

I- Air Pollution

Air pollution is defined as the presence of contaminates in the ambient air space in such a concentration and of such durations as to cause a nuisance to be injurious or potentially injurious to human or animal health, vegetation or properties or to interfere with comfort.

The source of air pollution may be either staionary or mobile and the pollutants may be suspended or settling particulate matters, various gases, or fumes and mists discharged to the ambient air.

In man, prolonged exposure to high concentrations may lead to damage of the respiratory systems, the digestive track, the skin and the eyes. Plants are more susceptible to air pollution, blockage of respiratory system by dust fall out on leaves and destruction of leaves by sulphuric acid concentrations etc. are occured.

The hazards of air pollution can be reduced by minimising the formation of waste gases by modifying

the production processes, covering all dust producing equipment and reducing the lump and powder material handling system; installing proper fume and dust extraction system and effectively cleaning the gases before discharging into the atmosphere.

II- Solid waste Pollution:

Solid waste or garbage Pollution is the problems of accumulation of large stocks of wstes mainly in and around the Urban centres creating a health hazard problem to the nearby population when the rain falls on the decaying solid wastes. It percolates and damages the underground water table. Solid wastes tend to settle where it is dumped and do not disperse by itself. This dispersion is therefore, to be done by man and thus solid waste problem can be regarded as largely a handling and transportation problem.

III-Noise Pollution:

Noise is an invisible pollution affecting human health and sense of well being. The sources of noise pollution are industries, automobiles, air-crafts, trains, loud speakers, etc. As all these sources are commonly found in industrial or urban areas, noise pollution is basically an urban and industrial problem.

The effect of excessive noise on man is detrimental to it's health such as mental illness, blood pressure, loss of hearing, ulcers and loss of high frequency a acuity were among a few important physiological effects.

IV- **Thermal Pollution:**

Industrial effluents and direct heat addition and hot industrial discharge in water ways are the major sources of thermal pollution. One of the most important sources of this is the thermal Power plants changing over from fossil fuel to nuclear fuel shall aggrevate the situation. The effect of thermal pollution are however, not too severe except that it is injurious to aquatic organisms.

One of the major control of thermal pollution is the increase in the thermal efficiency of power plants So that heat produced by burning fuel can be effectively converted into Power followed by installation of cooling towers and/ or cooling Ponds to reduce the temperature of hot dischargeable effluents before it reaches the natural water ways.

V- **Radiation Pollution:**

Radiation or radioactivity composes the most studied hazard in our environment today. With the advent to atomic energy either for peaceful purposes, or for war fare, the potential of hazard is increasing. One of the already felt problem is the storage of nuclear wastes and spent fuel. Highly radioactive wastes that are being buried in ground are extremely unsafe even if the burial is done in the most scientific ways known till today. This will remains dangerous not just for two or three decades, but for thousands of years to come endangering the coming generations.

VI- **Water Pollution:**

Water pollution may be defined as addition to water either in streams, lakes, lagoons or even seas anything which changes it's natural quality so that the user does not receive this natural water of the source. Water Polluion includes presence of disease producing bacteria and viruses and of undesirable ions and compounds in solution.

The effect of excessive water and soil pollution on man is detremental to it's health such as diseases like rholera; typhoiid, dyscentry, jaundice, diarrhoea,

tuberculosis, ulcers, cancer and some respiratory diseases are also caused by this problem.

Water Pollution may be classfied as Chemical, physical, Physiological and biological, Undesirable results from the discharge of the chemical materials include change is pH of water caused by soluble salts, depletion of dissolved oxygen and its resultant effect on biots and toxicity caused by heavy metals or other toxic materials. Under the category of physical pollution may be listed colour, turbidity, foam, radioactivity and temperature. Physiological effects are caused by taste and odour problems, particularly objectionable in water used for drinking or food processing.

Biological effects, concerned with public health are the occurance of pathogenic organisms in drinking water which can be disinfected by water treatment plants.

Water Pollution problems have become a grave concern to all, mainly due to the fact that the amount of fresh water available on the planet is very small being only 2.8% of the total world water. Out of this 2-8%, again fresh water contained in ice caps,

glaciers, and undergound water comprises a major portion of 2.75% leaving only 0.05% in lakes, rivers and soil moisture.

Sources of Water Pollution:

The main sources of Pollution are as follows.

I Domestic Sewage

II Industrial Wastes

III Agricultural Wastes

IV Radioactive materials and Mining Wastes

V Natural Pollution.

VI Population growth

VII Geology and Vegetation.

I- **Domestic Sewage:**

If domestic sewage is not properly handled after it is produced or if the effluent received at the end of sewage treatment plant is not of adequate standard, there are chances of water bodies being polluted.

Domestic sewage consists of spent water coming from wash basins, bath rooms, washing machines, kitchen etc. It also consists of living matter especially bacteria, viruses and protozoa (Mathur and Kaur 1972, Raman et al, 1983 Bhide 1983).

II- **Industrial Wastes:**

Industiral wastes are likely to pollute the water courses. The industrial wastes may carry a number of harmful substances such as grease, oil, explosives, heavy metals, pesticides, Acids, highly odourous substances etc. which are likely to pollute the water courses when discharged into it. The principal types of industries which contribute to pollution of rivers are chemicals, Fertilizers, Pharmaceuticals, coal washeries, hydrogenated vegetable oil and soap, Pulp paper, Sugar and distilleries, textiles and tanneries, steels mills, oil refineries and various other industries. (Forsther and Muller, 1974, Cameron 1978, Rao 1979, Srinivasan 1983, Bilgrami et al 1984.).

III- Agriculture Wastes:

The advances made in agricultural activities with the extensive use of fertilizers, and insecticides are main factors which may cause pollution to surface waters. The important pollutants to be found in surface run off from agricultural areas are sediments, animal wastes, wastes from industrial processing of raw agricultural products, plant nutrients (Nitrogen, Phosphorus, Potassium), crop residues, organic salts,

minerals and Pesticides (Stumm and Morgan 1970, Jenke 1974, Handa 1983.).

IV- **Radio Active Materials And Mining Wastes:**

The discharge of radioactive wastes into water from industries dealing with radioactive substances may seriously pollute the waters. The human activities which are responsible for radioactive pollution are,

(a) Mining and processing of Ores to produce usable radioactive substances.

(b) Use of radio active materials in nuclear weapons and nuclear power plants.

V- **Natural Pollution:**

The natural pollution arises from seepage of ground water. Stream wash, swamp drainage and aquatic life of streams and rivers. (Chopra 1982, Sharma and Ghose 1983).

VI- **Population Growth"**

The Problem of pollution is the uncontrolled growth which leads to urbanization and the activity of human population.

VII- **Geology and Vegetation:**

Regional geology and vegetation also effect the water and soil pollution, The sediment resulting from

soil erosion is today recognised as being the largest single pollutant affecting the quality of water (Robinson, 1973, Kardos and Sopper, 1974, Jones, 1979).

Casues of Environmental Pollution:

All societies produces wastes, but industrialization and urbanization have caused an ever increasing affluence and have greately compounded the problem of management.

Although tremendous quantities of liquid and solid waste from municipal, industiral and agricultural sources are being Collected and re cycled, treated or disposed off , new and innovative programs remain a necessity.

The following are some of the causes of environmental Pollution.

I- **Pollution Caused by Solid Wastes:**

The law of conservation of mass or material equally applies to the pollutants and while one cannot destory them, they may be changed from one compound to other. The presence of small amount of pollutants may have profound influence on human health.

As regard the nature of pollutants, the problem of pollution can be emphasised through a number of materials constituting soild wastes which are either domestic or industiral. Urban people dispose garbages and other solids to some public places or in open damps. The solid wastes include the following pollutants.

(a) Garbage:- such as wastes from kitchen, slaughter houses, canning and freezing industries.

(b) Rubbish:- Combustible wastes such as leaves, grasses, plants from garden, and non-combustible wastes such as bottles, crockeries and plastic materials.

(c) Large wastes formed due to demolition and construction processes, as for example-bricks, plastic, furniture etc.

(d) Sludge:- Settled solid components of sewage

(e) Dead animal wastes

(f) Industrial solid wastes, eg. chemicals, paints, etc.

(g) Agricultural wastes such as animal wastes, crop residue, besides fertilizers, pesticides and so on.

II- **Pollution Caused by Liquid Wastes:**

Under normal condition river takes care of many pollutants that enter it's body. Green plants and algae take up carbondioxide from water and in presence of sunlight synthesise carbohydrates and oxygen is produced by splitting of water molecules. Dissolved materials are taken up by bacteria and plants. Animals take up oxygen and give up carbondioxide and other compounds which are used by the plants. This is the ecological balance in the natural stream.

The important source of organic pollutants is sewage containing faecal matter, Urine, Kitchen wastes and some soil wastes. Sewage contains number of bacteria, both pathogenic and harm less bacteria. The strength of the organic wastes of sewage is measured in terms of demand disolved oxygen required in oxidation of organic matters by micro-organism. Since biological reaction is dependent on time and temperature this oxygen demand (called B.O.D. i.e, biological oxygen demand) is given for 5 days at 20°C. If the volume of B.O.D. is below 1500mg /l the sewage is termed weak wastes, if it is below 4000 mg/e it is medium and above this value it is termed strong wastes.

Domestic sewage in small quantities rarely gives trouble. However, if liquid wastes of industries enter the river water along with acids or alkalies and poisonous substances like cyanides, etc. The aquatic life in the river is affected and self purification system of water is impaired.

III- **Domestic Pollution Load:**

The most important factor of domestic pollution load is the presence of large number of "Khatals", In these Khatals, cows and buffaloes are kept in most unhygienic conditions. The wastes so generated get directly into the drain and after rain find its way to the river.

Another important producer of pollution load is from the domestic kitchen and bathing places.

IV- **Urban Pollutin Load:**

Among the most important pollutants in Urban effluents are organic load carried by the sediments and metallic and non-metallic inorganic constituents. The former also includes the pathogenes. The presence of these pollutants is bound to affect the B.O.D. and C.O.D. eutrophication and Pathogene micro-organisms such as bacteria and viruses. In fact, had there not

been the element of self purification by the streams themselves, the quantum of pollution would have been far in excess of that found at Present.

In this connection, the role of some microbiological activities in reducing the overall pollution effect has also to be kept in view, because such microbiological activities help the remoral of organic matters. However, the Presence of large organic matters reduce the oxygen content of water.

Rao and Dutta (1979) have shown that the self purification factor is rather a slow process. The usual conventional method to measure pollution load is by a procedure in which water is kept for 5 days at 20°C and B.O.D. are determined after chemical digestion process. Calculations of B.O.D. were made on the basis of 0.025 mg/capita.

V- **Organic Load:**

Organic load, in fact, is a single most important characteristic of any waste water. In this context, attention must be made of the huge amount of animal and vegetable wastes in the vegetable 'Mandis' where a lot of rotten vegetables and fruits are left lying in the road side for long time. Such pollution cause serious health problems.

The faecal matters lying in the village suburbs nearly always contains 'Esherichia' a dangerous form of coliform group. The aerogenes have a high degree of resistivity and they prolong for very long periods in the faecal matter till they are mixed with water and carried as run off. 'Gasteroenteritis' Polio, Typhoid, Spleen disorder and cholera are usually caused by such contaminations. It is very necessary that from the point of occurances of such Pathogenes and coliform the rivers and also the water of streams joining it are checked regularly.

Statement of the Problem:

The Present work is an attempt to evaluate the pollution caused by the excisting industries in parts of *Cochin*, the South-West Coast of India. The study area falls in the *Ernakulam* district of Kerala State. The district Ernakulam lies between North latitudes of 948° and 9° 58' and an East longitudes of 76° 14' and 76°17'. There are several large scale industries of Fertilizers, chemicals, Refinaries shipyard and Leathers etc. in this area. Most of these industries are located on the bank of *periyar river*, and are discharging their wastes directly into it without undergoing any treatments. Some are discharging their

wastes into *vembanad lake* which forms an estuary with *Arabian sea*. The present work is to measure the effects of waste disposal on quality of water in this area and their health hazards.

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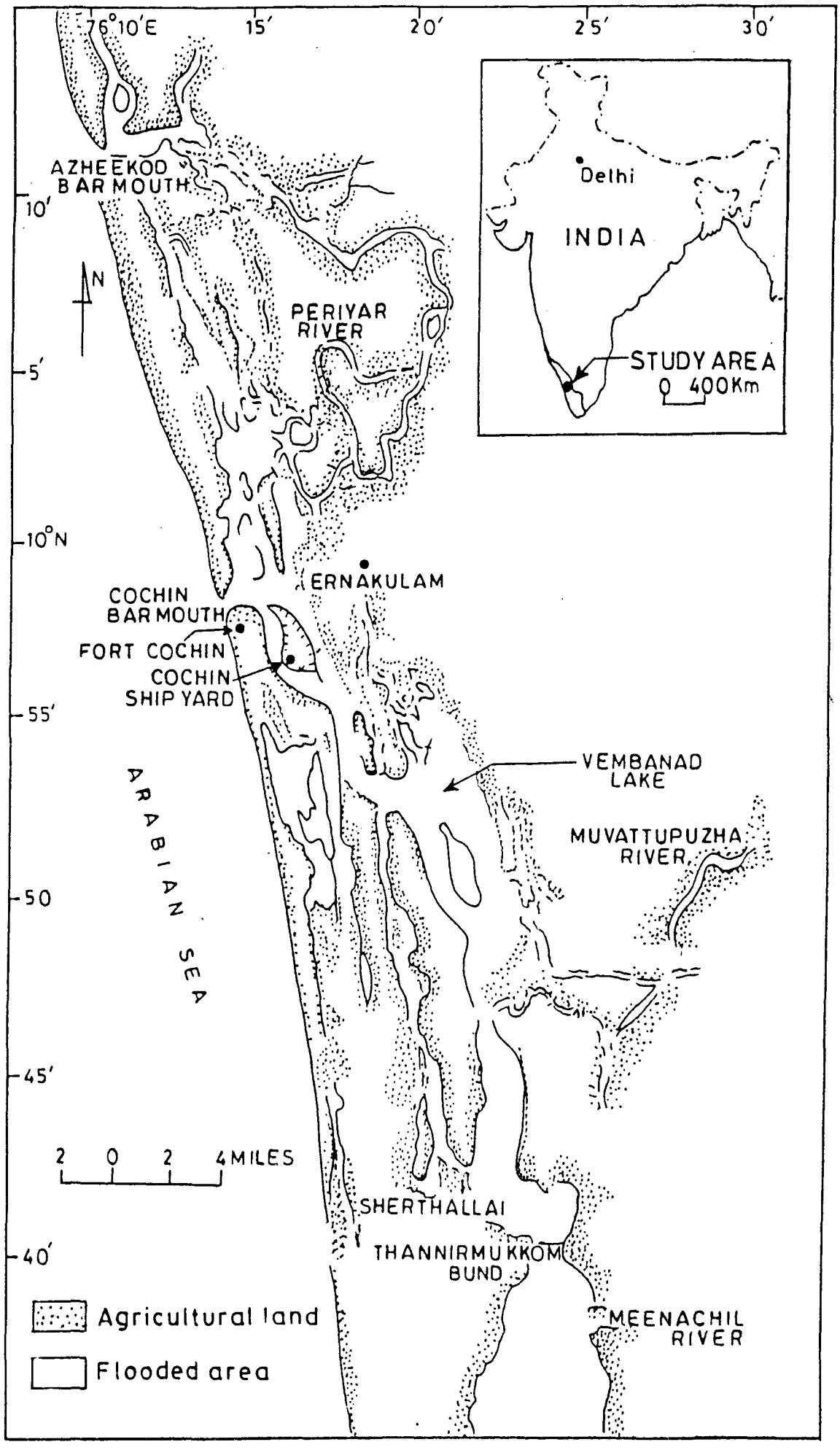


LOCATION MAP OF THE AREA

CHAPTER - II

GEOLOGY OF THE AREA

INTRODUCTION

Kerala lies between north latitudes 8° 15' and 12° 85' and East longitudes 74°55' and 77°05' and covers 38864 sq km . Situated on the West Coast of the Indian Peninsula, and accessible to the maritime influence from the west, Kerala has been important and most active for nearly 2000 years, from the point to view of history. it also offers one of the most fascinating geomorphological problems that even this geomophologically almost virgin subcontinent has to offer; and in fact no where in the country is the interaction between geomorphology and environmental forces and man, so pronounced, significant and important as in Kerala.

Geology

Rocks of Archean, Tertiary and Quaternary eras are found within the state. The Archean Crystallines include rock types of the khondalites, charnockite, sargurs and Dharwar groups, migmatites, granites, and syenites, basic and ultrabasic rocks intruded by Pegmatites, quartz-veins and basic dykes.

The study area is occupied by recent, Tertiary, and Archean formations. The general geologic succession as given by (John Kurien 1980 and C.G.W.B, 1988) is as follows.

Quaternary	**– Recent**	**– Alluvium and beach sands.**
	Sub Recent	**Red Terisands, black sandy clays and laterite.**
Upper Tertiary	**Vaikam bed**	**Semi consolidated sand stone, sand, gravel, clay, carbon clay, Marl and lignite.**
Archean	**Biotite**	**gneiss and charnockite.**

Another stratigraphical succession as proposed by Shivane.D & Ramachandran, A.,C.G.W.B. T.V.M, 1991) is as follows.

Age	**Formation**	**Lithology**
Quaternary Recent	**Alluvium**	**Sand and clay with flood plain deposits.**
Sub–Recent	**Laterite**	**Laterite capping of sedimentary formation.**
Tertiary L. Miocene	**Warkalai**	**Sandstone and clays with bands of lignite.**

	L. Miocene	Quilon	Lime stone and clay.
	Oligocene to Eocene	Vaikam	Sand stone with pebbles and gravel and bands of lignite.
	Eocene	Alleppey	Cerbonacesus clay and sand.
Archean	—	—	Crystalline basement khondalites and charnockites.

Recent:

Beach sands occur along the coostal part of the study area, with an average width of 0.5 to 1.0 km. These are essentially made up of fine to medium grained sands with lemonate. the alluvial beds in the area is represented by back water and lagoonal deposits brought down by the west folowing rivers. These deposits comprise of pure white quartz sands, dirty white silt, silty sand, grey to dark grey beach sands, red tery sands and black clay. These deposits along the beach get remarked by the waves and tides. These are unconsolidated sediments, with varying thickness.

Laterites

All the tertiary sediments are find to be laterised on the top indicating an emergence or sea level change. Due to this laterite capping demarcating the individual out crops of different Tertiary beds is difficult. The thickness of the laterite beds goes upto 30m in these along the surface where as upto 75m thickness was encountered in some of the bore holes. The laterite forms a definite geologic horizon in the sedimentary sequence in the coastal area.

Vaikam Beds

These beds were not known till recently and first encountered in the bore holes drilled by (C.G.W.B. (1976), These are laterised beds whereever these beds are exposed and perhaps all the laterised sediments seen along the upland portion constitute vaikam beds. O.N.G.C. has given the name 'Mayyanad beds'for this (Zutzhi et al; 1985). These beds are composed of thick sequence of coarse to very coarse sand and gravel and pebble beds interbedded with ash grey clay, Carbonaceous clay and thin bands of liginite.

The original shells of organisms are made of Aragonite and in Coarse of time it changes to calcite.

the shells with calcite in vaikam beds indicates that vaikam is the oldest followed by Quilon and warkalai.

Archean

Archeans are the basement rocks in the area. They are mainly composed of charnockites, khondalites, Biotite gneiss and basic intrusives. Charnockites are the predominant rock type, mostly massive showing some joint foliation in the north Eastern part. These rock are intensely folded, sheared and faulted.

Soil Characteristics:

Soil is the ultimate Product of the geochemical processes operating at the crust of the belt of weathering, modified by the combined effects of climate, biosphere, parent material, topography and time. Kerala being situated in a humid tropical zone with heavy precipitation and moderate temperatures has given rise to widely varying soil groups from similar parent materials.

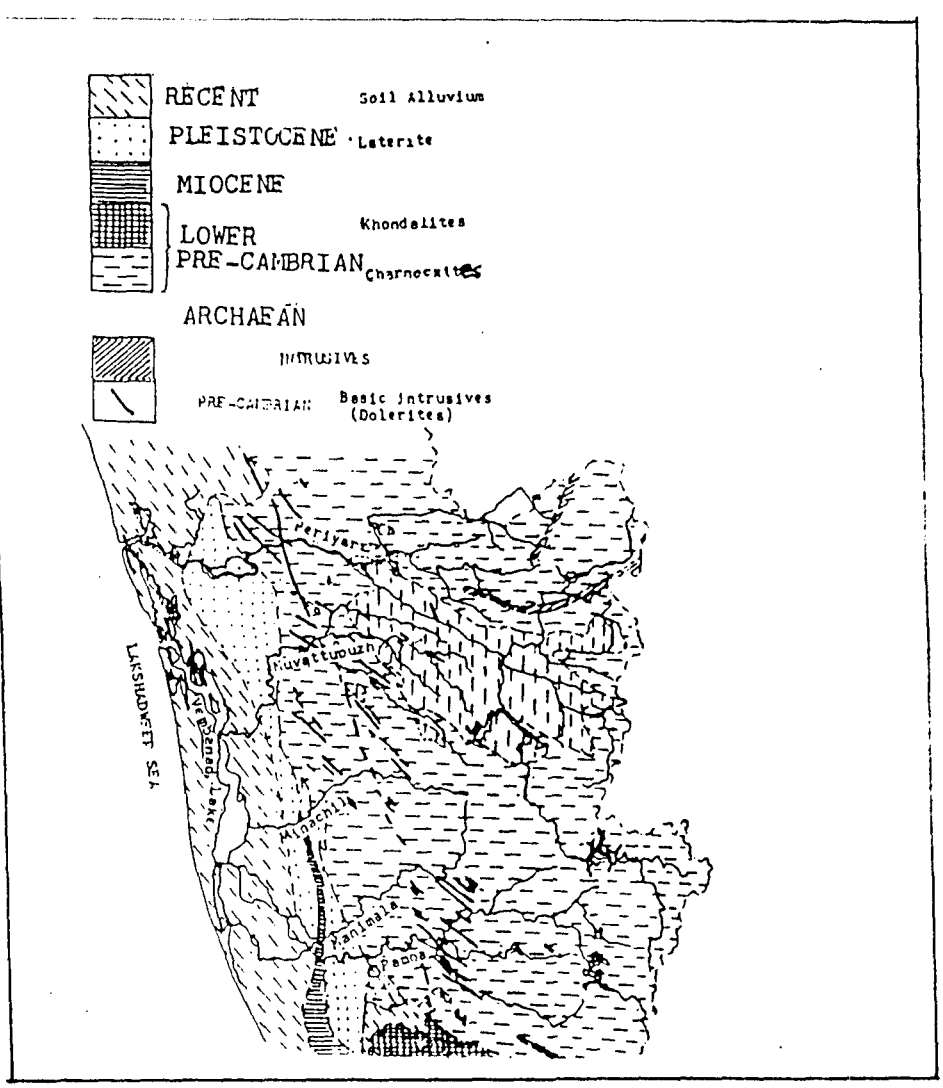
Laterite soil is the predominant soil group occur mainly in the midland, with medium elevation and hilly relief. Laterites can originate from different, parent materials, in humid, tropical climate with alternating dry and monsoon seasons. The contribution of climate, vegetation and topography or relief , is very much in

evidence with regard to the formation of laterites. Under exessive precipitation and high summer temperatures the rock undergo intense weathering, leaching away silica, alkalies and alkaline earth leaving behind hydrated oxides of iron and alumina which get accumulated in the B-horizons of the profile entrapping Kaolin.

Coastal alluvium is seen in the extreme coastal regions which has a low amount of clay. Sandy soils are diplorably poor in organic matter, a vital component of organic matter. The alluvial material originating from the forest and laterite soils have served as the secondary parent material for the recent formation of alluvial soils, sandy soil and peaty soils.

The main soil types of this study area are **coastal alluviums, Acid saline Riverine alluviums, Brown hydromorphic soil and forest loams.** Of this coastal alluvium and Acid saline are seen in extreme coastal regions. Brown hydromorph and forest loam are seen in mid land and high land areas respectively which supports thick vegetation.

M-2



Geology of the study area

CHAPTER – III

GEOMORPHOLOGICAL FEATURES OF THE AREA

The *Cochin Back waters* which form more or less a northward extension of *Vembanad lake* have all the charecteristics of a typical estuary, located along 09° 58'N and 76° 14'E on the South-West coast of India, The cochin backwaters system forms a positive estuary (Qasim and Reddy 1967), in Kerala having an area of about 300 k. m2 and located between *Azhikode and alleppey*. It is one of the largest estuaries on the west coast of India and is connected with the Arabian sea by a gut of about 450 m wide which forms the mains entrance to *Cochin harbour*. The gut makes way to transmit tidal energy and sea salts into the lake (Marikoth and Salih 1974).

The main source of fresh water in these backwaters are two large rivers. the *Periyar* on the North and the *Pampa* on the south and a small river called *Murattupuzha* which flows about midway betwen the two (Ramamirtham and Jayaraman 1960).

As a tropical estuary the conditions in this area are influenced both by the sea and by the fresh water influx. The effect of coastal upwelling, Mansoon piling

and sinking in the Arabian sea are considerable in the backwaters and help to bring about well defined seasonal pattern in the back water. (Ramamirtham and Jayaraman 1963).

The *Cochin backwater* estuaring system is a part of the lower reaches of the river *Periyar* which is one of the largest perennial river of this area. (Sankara Narayanan et al 1986).

The effluents discharged into the backwater system from various industiral establishments, located in *Floor (Udyogmandal)* constitute some of the major pollutants in the estuary which contains considerable concentration of tracemetals including Cu, Mn, Zn, Co etc. The industrial belt extend to nearly 16 k.m. from *Varapuzha* to *Aluva* along the upper reaches of the backwater. (Seralathan et al 1979).

WellerShaw (1971) studied the hydrographical features of Cochin backwaters and the three seasons experienced there are described as follows.

1- Pre-Mansoon Season from January to May

2- Monsoon season from June to August

3- Post-Mansoon season from September to December upwelling, sinking, coastal current etc. also exert a significant influence on the hydrographical features of the estuary.

Physio Graphy:

Physiographically the district can be divided into three divisions.

1- Lowland to the West Coastal Plains

2- Midland area of pene Plains

3- A high land of the East forming part of western ghats.

1- **Coastal Plains:**

The coastal Plains appear to extend upto 7 km or more from the present coast line and it runs paralel to the Coast. The coastal plain is traversed by streams draining into the Arabian sea. The elevation of of area ranges from 1m below mean sealevel to as much as 6 m above mean sea level. A large part of the study area belongs to this coastal plain.

Geomorphic land forms identified in the coastal area, a part of low land, and beaches, shore plat forms, spits and bars, beach ridges estuaries, and

lagoons, mud flats and tidal flats. The kayals are the estuaries which are submerged river mouth. These kayals are prove to receive sediments from land ward. There has been considerable reclamation of cultivation land in the last 100 years. The present shore line is straight, trending NNW- SSW with minor variations. The active sea erosion is seen at many places. the beaches are very narrow.

Nair.K (1987) has given detailed description of the coastal geomorphology of Kerala and classified the shore line as

(a) Cliffed emerged shore line
(b) Neutral shore line
(c) Prograded and emerged shore line.

2- **Midland area of Peneplain:**

The midland regions is marked by two geomorphic units; these are

i- Thye plateau like landform covered by a thick blanket of laterite which is immediately to the east of coastal plains and rises upto 20m above mean sea level. This laterite is quite thick, at times attaining a thickness of even 26m. The

mounds occur all along the midland portion i.e., between the main out crop area and the coastal zone

ii- Second geomorphic unit in this zone is represented by infilled valleys, which occur between lateritic mounds and vary in size from 100m to 3.5 k.m. These valleys comprise alluvial sediments and are thickly cultivated. The hilly tract along the eastern portion constitute the rugged terrain. The eastern highlands exibit one typical topography with steep hills, dissected by deep v-shaped valleys cut by youthful rivers.

3- **High Lands:**

This is part of Western ghat lying in the eastern side of the district. These are mainly the hilly ranges with out crops of Biotite gneisse and charnockite.

Climate And Rainfall:

Climatically the area shows very moderate variations. According the Thornthwaite's (1985) climiatic classification, the basin comes under wet type of climatic conditions (C.G.W. B 1988) In general four seasons are identified, the hot summer season from March to May-South West Monsoon season from June to September, North Monsoon season, extending from October

to December and a cool climatic period during January and February.

3050 mm rainfall occurs annually in the area on an average. Maximum rainfall occurs during south-west monsoon period extending from June to september and nearly 72% of the total rainfall is received during this period. Out of 154 total rainy days registered during the year 1989, 98 days are accounted for during the South-West monsoon period. 15.1% of the total rainfall is received during October to December, 12.4% of the total rains fall is received during march to May and the balance 0.5% is accounted for January and February months.

Geomorphology:

The coastal area of Kerala is charecterised by a barrier strip of land between the Arabian sea and a chain of back waters (Kayals), estuaries, and river outlets. There are fourty-four rivers out of which fourty-one flow westerly from the Western Ghats to the low areas of backwaters and lagoons near or at the coast. The coastal area is mostly of subrecent to recent sediments. It is noticed that the portion from *Quilon* to *Quilandy* is an alluvial belt covered by laterite deposits.

Laterite out crops are seen at this region along the coast at *Varkalli* in the south and at *Tellicherry* in the north.

The concentration of heavy minerals like ilmenite, Monazite, rutile, Zircon in the coastal area from Neendakara to Kayamkulam is an important feature of the coast. They are present at an average depth of 8M.

Tides and Storm Tides:

The mean tidal range varies from 0.9m in the south to 1.8 m in the north. The tides are of the semi-diurnal (12 hour) type. The coastline is very low and coastal areas are flooded by storm tides in many sections during the southwest Monsoon.

Waves:

The sea is rough during the monsoon months (May to september), when the high waves with the storm surges attack the coast. The highest waves average 3.2m and the wave periods of 5 to 12 secs are observed.

Littoral Drift:

Littoral Drift may be defined as the beach material moved parallel to the coast in the nearshore region of the sea caused by waves approaching the beach

at an angle. The predominant direction of littoral drift on the Kerala Coast is towards South. This has been established from an analysis of the developed data. It is also noted that there is seasonal reversal of littoral drift all along the coast. The trends indicate southward movement during may to September and northward and movement durng the rest of the year.

The quantum of gross littoral drift works out to about 1.25 million cubic meters/year.

Drainage:

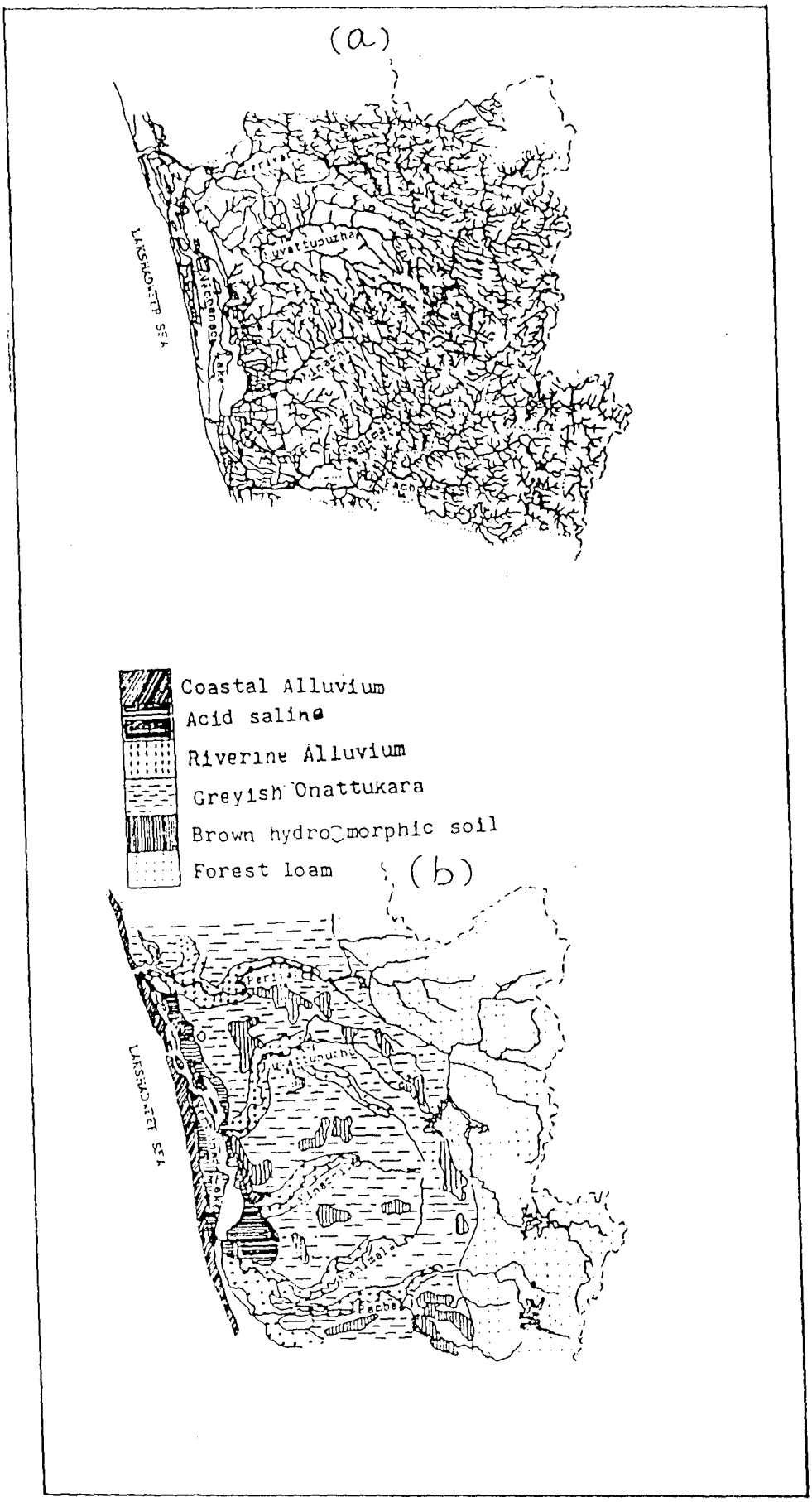
The drainage of the area remains an expression of the general structure and is affected by the rivers and backwater system. The area is a low lying flat country handly exceeding 5 m above means sea level. It is cris-crossed by a number of backwater channels and rivers. the study area is drained by *Peryar river, Pampa, Muvatupuzha, Minachil, Manimala* and their various tributaries, and *Vembanad* lake which is a tidal lagoon occupies the central part of the area. Like majority of Kerala rivers, these are quick flowing and are in their youthful stage.

Periyar is the major river in this area, originating from the Western ghats which bifurcates into *Periyar Floor branch* and *Periyar Edamula* branch.

Floor branch flows westwards and joins the vembanad lake. Edamula branch flows in a southern directions upto *cheranellur* and then flow westwards to join the vembaned lake. The Eloor branch is charecterised by uneven pattern of flow and meandering course and hence the flow in this branch is very sluggish.

Pamba, one of holy rivers of India flowing at the foot hills of Sabarimala is being used by more than 25 lakh of devotees every year.

Mavattupuzha also originates from western ghats and flows westwards and finally joins the Arabians sea. The drainage of this area is also effected by the backwater channels which dischange into the tidal lagoons in the central part and into the Arabian sea on the Western part.



Drainage pattern (a) and soil types (b) of the study area.

CHAPTER - IV

ENVIRONMENTAL IMPACTS OF GEOLOGY AND GEOMORPHOLOGY

Geomorphology is reflected and has a profound influence on the population, settlement pattern, occupation, river water and ground water resources, soil, land utilization, agriculture, crop pattern etc. The landslides, floods and coastal erosion are also related to the rejuvenation of faults and tectonic disturbances at the present day.

Population:

Accordng to the 1971 census, the population of Kerala was 213.47 lakhs and density was 549 per sq.km, the highest for the country. Within the state, density is highest in the beach, the flood plains, and the deltas settlements also show a preferred orientation. In the beach, the settlements are in a linear pattern on the beach ridges, but in inland the settlements are found at the fringe of the deltaic and flood plains . In the midland, the settlements form a ring round the lateritic plateau, and are situated on the lower part of the flanks, the alluvium. Also it will be noted that the settlements are near to the sources of fresh water.

Occupation:

On the beach, people have tended to become sea faring, only because of the Poor soil and litle or no land suitable for cultivaion. Agriculture is confined to the fllod plains, and delataic plains, and to a small extent in the swales in the coast, and in the valleys in the high hill ranges Plantations are found on the lateritie rises, the peneplain, and to some extent in the high ranges. Forests are confined to the hill ranges.

Health:

Pollution of land and water in the beach is enormous, which has a serious effect on the health. Also it will he of interest to record here that the incidence of Filaria is high in this tract, where the swales and deltaic plains, with no proper drainage, serve as centres for breeding of Mosquitos.

Land Utilisation

The area under the classification-barren, uncultivable, fallow, other fallows, cultivable waste, permanent grasing lands and Pastures comes to 209990 hectares, which could be considered for cultivation. Unsuitability of the land may be due to the fact that

the land is rocky, or marshy, or lack of irrigation.

A considerable part of Kerala is convered by laterite which is at places hard, but more often weathered on the surface to variable depths. To begin with, a scheme for plantation of rubber, cashew, etc. could be launched in such tracts. Reclamation of marshes, backwaters and tidal flats, and also land from the sea, requires serious consideration, which is not uncommon in several parts of the world, where reclamation is done by construction of walls and dykes and then filled with sand from the backwaters.

The area under culivation is 2208451 hectares, of which in only 819624 hectares more than one crop are sown. Areas should be demarcated which could be brought under cultivation of more them one crop by irrigation .

Crop Pattern:

Rice cultivation occupies the largest extent of land mostly in the detaic and flood plains of the river and to some extent in the swales in the beaches, and in the valley fills in the high ranges. Pulses, rubber, and ginger grow well in the lateritic peneplains and in the colluvium, the slopes of which are not too steep and swampy.. Coffee and tea are confined to the high

land, Coconut and tapioca are grwon and yield well in the bar beaches, on the colluvium and on the borders of the river-built plains. Cashew flourishes well in any waste land in particular, in the beaches and on the peneplains.

Soil:

The soils of Kerala fall under (a) sands which form the beaches, heavily drained and poor in Plant nutrient. Addition of clay and silt, increases the water capacity and then this soil becomes holding productive: (b) black loam of the flood plains, deltas and swales. These are reported to be rich in organic matter, nitrogen , and Potash and are slightly acidic "These are found to be very fertile: (c) red loam of the colluvium, rich in aluminium , iron and nitrogen but poor in calcium and phosphorus,: (d) red silt and clay or the regosol of the hill ranges, which support thick vegetation.

Water

Nature hs endowed Kerala with good rainfall. There is a general presumption that because of the heavy rainfall and the numerous rivers, Kerala does not require any irrigaion. Because of the heavy rains, there is some kind of cultivation all over the state;

but this depends on the precipitation incidence, season and distribution of the monsoon. Crop failure and drought conditions are not uncommon, if not fuequent, when the rains fail.

There are 44 rivers and the number of river basins in 32, It is reported that the water resources are more than that which is actually required. The requirements for irrigation are expected to increase in course of time when more land is brought under cultivation, and attention is given to raise more than one crop, by irrigation. In many of the river basins, the water reserves are much less than required' subsurface water is another source but of very limited extent. In the high land, construction of large diameter open wells will be the only method of tapping the ground water. In the peneplains, colluvium, flood plains and deltas, only open wells are feasible. The beach has been under investigation and the sedimentary rocks have been found to contain several moderately productive aquiters; but even hence, caution is to be exercised and local development of the aquifers will result in contamination of the a quifers by saline water intrusions from the backwaters and the sea. Only a few of the more important townships and villages

have a system of protected water supply, but the source of water for domestic use in the interior villages, is only from the open wells in the colluviums or the flood plains, and that too situated at considerable distance from the homes.

It is therefore all the more necessary to conserve the river waters to counter the vagaries of nature and to stabilize cultivation. Diversion of river waters from one basin to another is possible and requires consideration for irrigation. This will not only bring more land under cultivation and help to raise more than one crop; but will also serve to control floods.

Soil Erosion

Soil erosion assumes a special significance in several parts of Kerala and it is reported that nearly 10 lakh hectares of arable land is subjected to this hazard. Contouring and terracing will be most effective to control soil erosion. This will also provide an important means of water conservation and flood control.

Land Slides

Land slides constitute a part of the natural geological cycle and are prevalent in the *periyar river*

basin, and also to a lesser extent in the *wynad tract*: In Kerala land slides could be correlated to a rejuvenation and disturbances in the fault zones, with consequent changes in the level and gradient of the landforms and a change in the ground water conditions. Drainage is the key to the control of land slides.

Floods

Flood is a phenomenon which has to be accepted as part of the natural order and is most common in the deltaic and fllod plains of the rivers in the lower reaches. In the periyar river basin, it is very extensive. Flood control can be achieved through construction of large check dams, and stream channelisation.

Sea Erosion

Sea Erosion on the coastal tracts, often a common feature in the past, hs now become frequent, and is more pronounced in the *Alleppeyt* and *Ernakulam* districts. The sea erosion may be due to rejuvenation of certain faults on the coast, when the equilibrium is being sought to be set up by erosion and depositions. Groins and sea walls serve as a protection against sea erosion, but they should be used with caution. Also they may not be economical and permanent. The best

weapon, reported is to nourish and replenish, the beach with sand from the lagoons and bays and from the offshores. Till such time the settlement patterns on the coast, will have to be changed.

CHAPTER - V

HYDROGEOLOGY OF THE AREA

Hydrogeologically Kerala provides a pleasant set up for the occurance and development of ground water. Vast reserves of ground water occur different subsurface environments in the state. Of these the coastal soft rock-sedimentary formation constitutes an important system. The coastal terrain which supports a very high density of the population in the state can depend, this system to a considerable extent for its day to day needs of fresh water. Attempts for exploiting ground water potential in this area started as early as nineteen fiftees. The wells are drilled and maintained by Erstwhile water works division of public works Department for prividing drinking supply. Included under their regional exploration Programmes the Erstwhile exploratory tube-well organisation and Geological survey of India had carried out some regional studies in this part of the state during the year 1954-60: However these studies were not followed up by detailed investigation. The state ground water department and central Ground Water Board Govt. of India had initiated studies in 1970's

Ground Water Resources of Cochin-Shertallai Area:

Introduction:

The coastal belt of Kerala though receives abundant rainfall during the S-W monsoon period, due to the presence of extensive backwater channels and tidal lagoons, fresh water supply is scarce specially in the dry weather period between January and May, every year. Hence Ground water investigations have been initiated by the Geological survey of India as far back as 1954 to evaluate the ground water resources of the coastal belt for developing the same for domestic, Municipal, industrial and irrigational uses. For more than a decade hydrogeological investigations coupled with exploratory drilling have been taken up by the G.S.I, Central Ground water Board, Public Health Engineering Department of Kerala and Kerale State Ground water survey in the coastal belt of Kerala.

Previous Work:

Ground water investigations in the coastal belt of Kerala was initiated by Geological Survey of India in the year 1954. G.C. Taylor of U.S. Geological Survey and P.K. Ghosh and M.S. Balasundaram of G.S.I. have carried out hydrogeological reconnaissance all along the coastal plains and the adjascent in land areas.

Systematic hydrogeologicl surveys were carried out by S.Ranganathan in the year 1960.

Exploratory drilling was taken up by the public Health Engineering Department, Government of Kerala in (1965) in *Greater Cochin area*, to find out ground water resources for water supply to *Cochin-Ernakulam* towns. However, as deep drilling in this area have revealed poor quality of formation of waters, the area has been abandoned. At the request of govt. of Kerala, further exploratory drilling in *shertallai-Cochin* area, (South of Greater Cochin) was taken up by the central Ground water Roard to evaluate the ground water potential as well as its ' suitability for domestic and irrigational purposes.

A Quiffer Charectoristics:

on the hasis of seismic velocity charectorstic, the coastal belt can be divided into three blocks, namely, the southern, the central and the northern blocks (R.N. Bose and T.D.G. Kartha, 1980). In the southern block only one major sedimentary sequence, the Tertiaries is indicated above the basement. The Tertiaries are either exposed or lie under a thin cover of recent formations. In the central block, extending hetween *Karunagapally*, in the south and

periyar river in the north, the Tertiaries are indicated to underlie a thick column of younger formation, possibly of pleistocene age. Sediments under this group have a maximum thickness of about 90 M in the coast. This group of sediments is overlying by the recent sand and clays, having a maximum thickness of about 30M near the coast. In the northern block extending towards north of periyar river, athin layer of Tertiary overlying by the Quaternary formation is exposed. The total thickness of sediments in this block varies from 40 to 100 M.

Alluvium:

The quaternary alluvium forms potential aquifer along the coastal belt Ground water occurs under phreatic conditions in this area. The alluvium essentially comprises of sands, clays, and silts, and is extensively developed by a number of dug wells and filter point wells to meet the domestic needs. The thickness of this formation varies from 12 to 21 meters. The dug wells range in depth from 4 to 6M. Depth to water level during pre-monsoon period ranges from 0.25M to 5.0 M. Most of these are draw wells and a few are fitted with small capacity centrifugal pumps.

In the study area around cochin and Ernakulam there are a number of filter point wells and shallow dugwells in operation to meet the needs of domestic requirements and ice factories and other industries. A few of these are also used for irrigation. The filter point wells are in the depth range of 6 to 10M, with slotted length of 1 to 3 M. at the bottom. In the case of dugwells during rainy season water table lies generally within a metre below ground level.

Laterite:

Laterite, being a highly porous rock acts as good aquifer, but due to the same nature, the ground water in them drains off particularly along the hills and slopes. Laterite is extensively developed by open dug wells, to meet the domestic needs. Wells located in the valley portions are used for irrigation to a limited extend. The depth of the wells in the laterites ranges from 9.3 to 19.0 M and the depth to water level in these wells vary from 6.35 to 10.04M in the pre-monsoon period. The yield of wells ranges from 60 to 120 M^3/day. Wells located in the valleys generally have highe yields wells located in the slopes and in higher ground get dry or have very little water during summer months.

Tertiary Sediments:

Ground water occurs under unconfined to semiconfined conditons in the vaikam beds constituting the Tertiary sediments. The aquifer material comprises of very coarse grained sand and gravel, clay etc. The basement rock is encountered within a depth of about 75 to 85M.

Occurrance of Ground Water:

Ground water occurs under water table conditions in the beach and alluvial sands and it is developed by means of shallow dug wells and Ponds. The water table lies generally within a metre below ground level during the rainy season. Since the area is low lying, hardly exceeding 5m above means sea level; the altitude of water table is generally from 1 to 3m above M.S.L. The sand beds occur in the form of narrow bars and small humps criss-crossed by backwater channels and the water table in them slopes towards the channels.

Ground water occurs under confined conditions in the sand and gravel beds of the upper Tertiary sediments. The elevation of the Piezometric surface ranges between 0.65 MSL and 5.14m above MSL, and in most of the area it is above the ground level,

resulting in artesian conditions. The thickness of individual aquifer varies from 1.8m to as much as 15.6m. As the thickness of the sediments increases from the inland margin towards the coast, the number of aquifers and their combined thickness also increases from the in land margin towards the coast. The maximum number of aquifers encountered in the area near coast is seven in number with a combined thickness of about 47M. (G.S.I.)- (1954).

Out of six exploratory boreholes drilled by (G.S.I.) in the area test wells are constructed only at four places. The other two boreholes were abandoned as the formation water was brakish. Apart from the six exploratory borholes, four slim holes were also drilled in the area to delineate the extension of the aquifers. The specific capacity of the test wells ranges from 28.5 M to 92 M. Long duration pumping tests were conducted in these test wells to find out the hydraulic properties of these aquifers.

The total thickness of aquifers tapped in these test wells ranges from 6.7m to 27.4 and their combined. transmissivity varies from 34 cu m/day/m to 273 cum/day/m . The storativity of the aquifers ranges from $3.46X10^{-3}$ to 4.37×10^{-3}

The chemical quality of water from the tertiary aquifers varies widely not only between different aquifers but also within the same aquifer in short distances.

All the bore holes were electrically logged and on the basis of the electrical log, a preliminary assessment of the quality of the formation water from each aquifer was made. Aquiferwise quality tests were conducted for those aquifers which show permissible or moderately good quality of formation water in the electrical log.Test wells were constructed tapping only the aquifers containing formation water showing salinity within the permissible range.It can be seen that almost all the aquifers at *Kandakadavu* and *Chellanam* contain water with total dissolved solids ranging from 2100 to 2400 ppm or more. On the other hand the middle aquifers at *Kumbalaryi* and *Chandirur*contain better quality water with total dissolved solids less than 1800 ppm.The quality of water improves towards south and southeastern parts of the area as all the aquifers in the boreholes at *Thykkattuseri* contain water with less than 1800 ppm of total dissolved solids and the bottom-most aquifer contain water with less than 1200 ppm of total

dissolved solids.Hence there is a progressive improvement in the quality of water from North to south as well as from west to east. The only aquifer tapped in the test well at *Udayanapuram* on the eastern side of Vembanad lake contains water with less than 1100ppm of total dissolved solids.

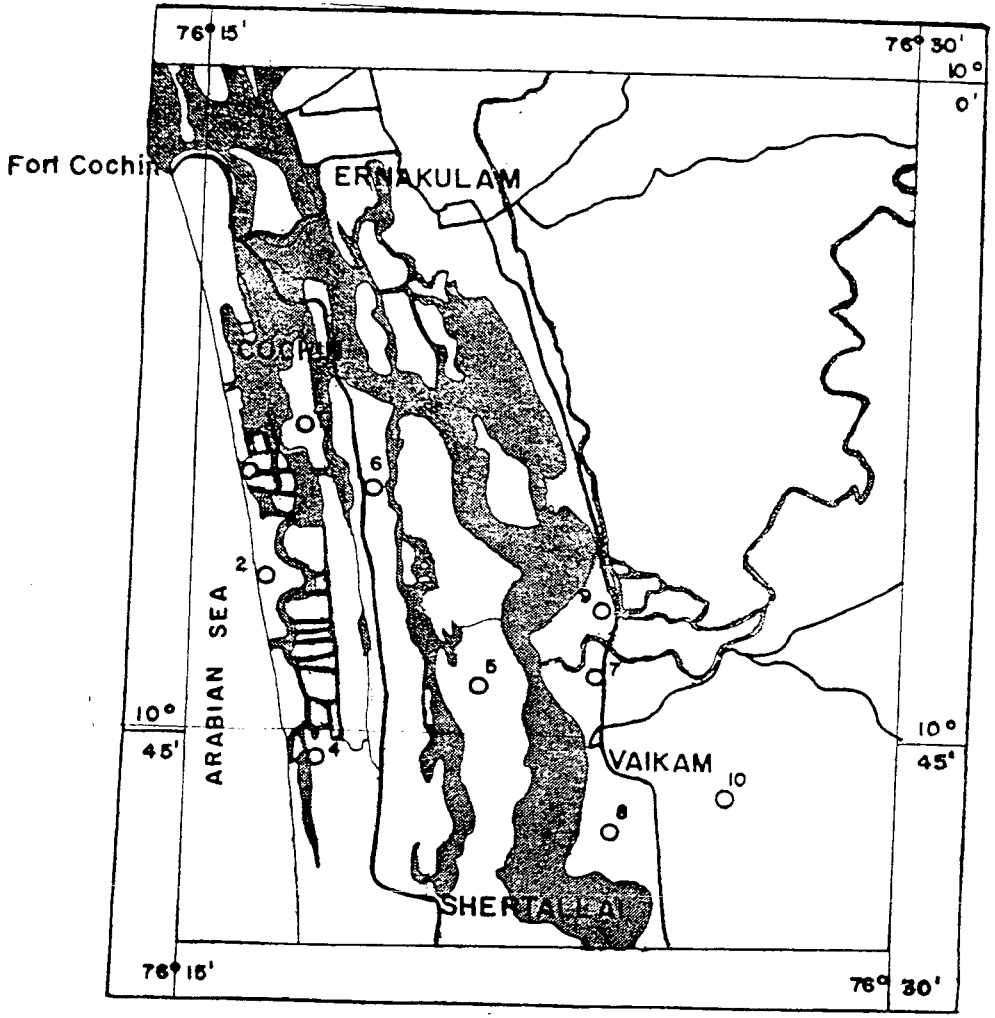
Hydrogeological studies coupled with exploratory drilling in the area between *Cochin and Shertallai*, on both sides of Vembanad lake have indicated that the ground water nesources of the area are limited owing to the severe restriction composed by the chemical quality of formation waters. As shallow water table aquifer yields brakish water during the summer months, permanent water supply should be obtained only from the deeper confined aquifers.As there is wide variation in the chemical quality of water even in the confined aquifers, aquiferwise quality tests and sealing of the top aquifers which contain more brakish water is necessary while contructing the tube wells . In the area between *Kumbalangi and Chandirur* the middle aquifers at depth range from 70 to 110 M. Contain better quality water than the top and bottom aquifers while in the area south of *Chandirur* and east of *pattanakad* the bottom aquifers contain better water than the top ones.An area of about 12 sq.Km around

Udayanapuram and about 30 sq.Km around *Thykkattusseri* was found suitable for ground water development by means of tubewells from the upper Tertiary sediments.

MAP OF COCHIN – SHERTALLAI AREA –

SHOWING THE LOCATIONS OF THE EXPLORATORY BORE-HOLES

SCALE – 1 : 2,50,000

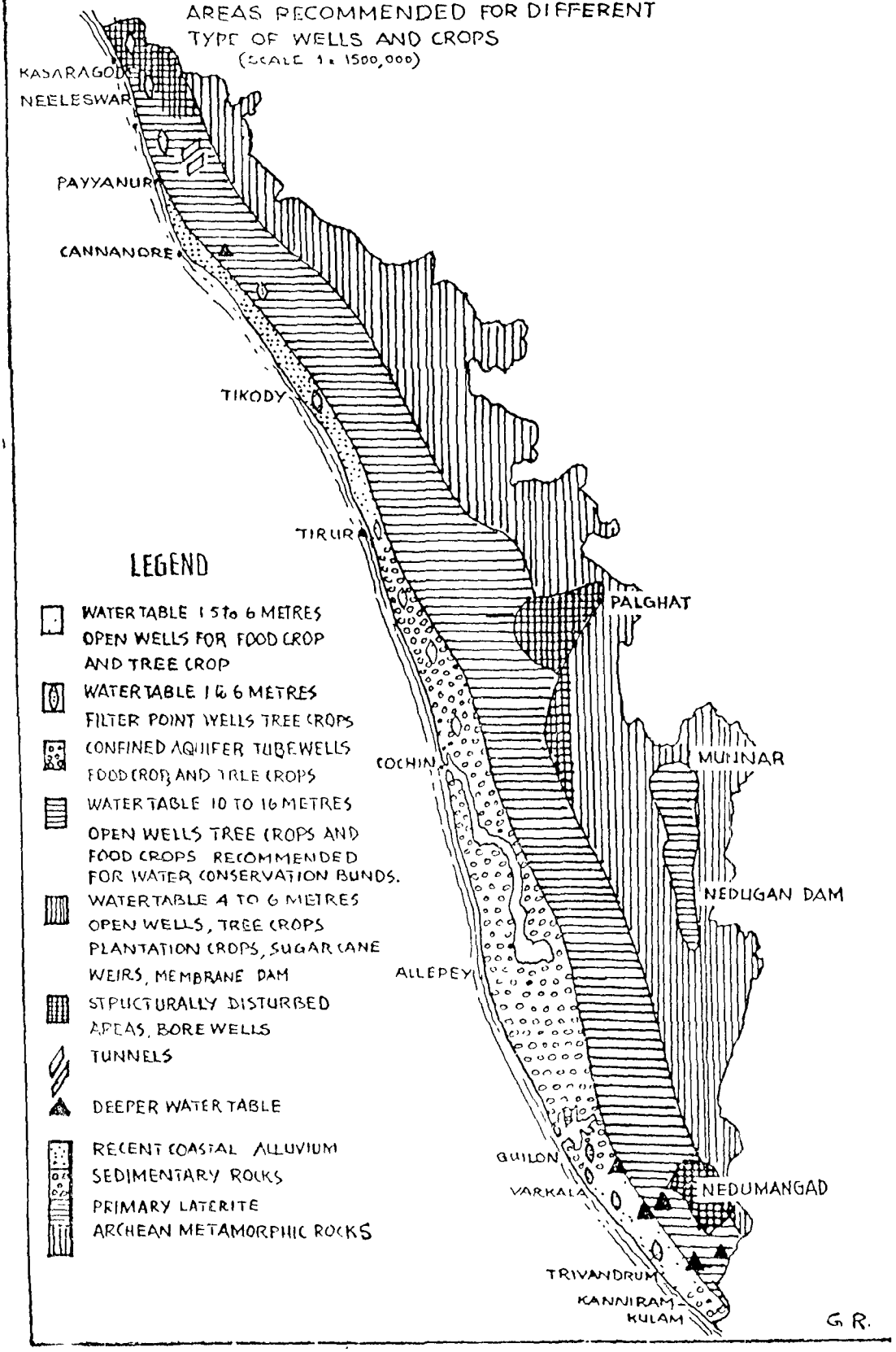


M-4

HYDROGEOLOGICAL MAP OF KERALA

AREAS RECOMMENDED FOR DIFFERENT TYPE OF WELLS AND CROPS

(SCALE 1 : 1500,000)



CHAPTER – VI

HYDROCHEMISTRY

Water is one of our basic natural resources. An understanding of the quality of water is most important for evaluating its usability in agriculture, domestic and industrial water supply. The chemical and biological characters of water determines its suitability for various purposes. The existing chemical composition of surface water and ground water is related to the environmental conditions in general, and as well as geological, Petrological, and topographical conditions in particular.

Collection of Water Samples

To determine the intensity of pollution the water samples were collected from various stations located near the industries. The water samples have been collected with the help of plastic bottles of 2 litre size. near the centre of flow of Periyar river (U-I) and vembanad lake (U-II). The bottles were properly rinsed with 0.1 N. HNo_3 and then washed with demineralised water in order to avoid any type of contamination. Few parameters like pH, temperature colour etc. were determined on the site itself. In a

order to check the change in composition of water which effect in the determination of trace metals, the water samples were preserved with 10 ml of 6N. HNo_3. some industrial effluents were also collected for the determination of major and trace elements.

ANALYTICAL TECHNIQUES

The samples for detailed chemical analysis (Major and Minor constituents) were analysed as per standard methods recommended by APHA (1975). Jackson. M.L. (1985) and Trivedy R.K., Geo P.K. (1904).

Volumetric Techniques used for the determination of all the major ions except sodium and Potassium. Sodium & Potassium were analysed with the help of flame photometry. The trace elements were determined by Atomic Absorption spectrophotometer. A blank sample was made for each spectrophotometric analysis in order to account for any analytical and instrumental error.

Major Elements and Radicals:

Hydrogen Ion Concentration (pH):

Hydrogen ion concentrations in water is the logarithmic reciprocal of their weights measured in grams per litre of water. The pH value of acidic water

varies from 0-7 and that of alkaline water between 7-14, while neutral water has a pH value of 7.0 . Mostly the fresh waters have a pH vale of 6-8.

The pH. value of the area is ranging from 4.5-7.6, in unit I and a value of 7.2-8.3 in unit II. Most of the values are well within the permissible limit for potable water but unit I shows slightly acidic nature of water near the Industries.

Chlorides (cl^-):

Sodium and calcium chlorides are found in natural water, but are harmful to fish in high concentrations. The chloride content in drinking water is generally not harmful to human being until a high concentration is reached. Although chlorides may be injurious to people suffering from diseases of heart or kidney. Indian council of Medical research (1974) while recommending 200 ppm as desirable limits of chloride in potable waters has laid down 100 ppm as maximum permissible limit where no other alternative source is available.

The chloride concentration in the study area is ranging from 28.4-369.2 ppm in parts of Eloor (Unit-I) and a value of 11050-12105 ppm in Unit-II i.e. in Vembanad lake . It is found that the concentration of chloride is increasing towards the sea side.

Bicharbonate (HCO_3^-):

Bicarbonate concentration in the study area varies from 36.6 ppm-91.5 ppm in Eloor region and 465-540 ppm in the samples of Vembanad Estuary.

Total Hardness:

The hardness is usually caused by carbonates sulphates, chlorides and nitrates of calcium and Magnesium. The hard water is not unfit for drinking purposes unless the hardness in excessive but it consumes more soap in loundries and forms depostis (boiler Scale) in boilers. Too soft water is tasteless.

Water have been classified as hard or soft according to their action on the soap. The less amount of soap is consumed to produce leather the softer water. hardness is expressed in terms of calcium carbonate, on the basis of which the following classification is used.

1- Less than 50 mg/l - Soft

2- 50 to 100 mg/l - Moderately soft

3- 100 to 150 mg/l - Slightly hard

4- 150 to 250 mg/l - Moderately hard

5- 250 to 350 mg/l - Hard

6- More than 350 mg/l - excessively hard

While hardness is caused only by cations such as calcium and magnesium and consequently is independent of the anions in the solution.

The hardness in the study area varies from 130-730 ppm is Eloor region and 5620-6856 ppm in the samples of vembanad Estuary. The high Hardness is due to the direct contact of saline water bodies.

Calcium (Ca^{+}):

Calcium is an essential element and human body requires 0.7 to 2.00 gm per day. The absence of calcium in very soft waters has been considered responsible for rickets decayed teeth etc., while hard waters having high calcium concentration may add to urinary disorder etc. The limits of calcium in drinking waters are not based on health consideration as even waters having 100 ppm of calcium is harmless.

The calcium concentration in the area varies from 16.03-134.26 ppm in Eloor region and 975-1175 ppm in vembanad Estuary. The highest values are recorded in the backwaters and Industrial effluents.

Magnesium (Mg^{++})

Magnesium is common, moderately toxic element and is found in almost all water supplies. If high

concentration of magnesium is combined with sulphate a laxatile effect results, therefore some caution must be exercised with it. Magnesium is also a constitutent of hardness. The permissible limit of maagnesium content for drinking water purpose varies from 50 to 200 ppm(W.H.O).

The magnesium concentration in the study area ranges from 18.27-97.45 ppm in Eloor region and 100.9 - 1125 ppm in the Estuarine water. The highest values are recorded from estuarine waters and Industrial effluents:

Sodium (Na^+)

The most important water quality aspect of sodiums is the posiblity of changing the permeability of soil. sodium is present in all natural water. Sodium concentration in drinking water around 200 ppm may be harmful to persons suffering from cardiac and renal dfisease pertaining to circulatory system. Sodium in the study area ranges from 5.2 ppm to 198 ppm in Unit I and a value of 420.0 ppm to 720.0 ppm in vembanad lake of Unit II. The highest value is recorded near the coast and backwater bodies.

Potassium (K^+)

Potassium concentration in the study area varies from 1.2 ppm to 136 ppm in Unit I and a value of 36 ppm to 183.0 ppm in waters of vembaned lake. The values are found to be increasing towards the coast.

Trace Elements:

For every metal which man make use of in the modern technological society is a potential source of pollution of the biosphere. Further more. the multiplicity of the industrial process give rise to a continously changing pattern of distribution for each element in the biosphere creating in turn their own characterstic ecological consequences. Industrial effluents and wastes discharged into coastal water are ofcourse eventually dispersed and diluted in the ocean. These waste water disposals are in direct contact with the coastal aquifers, which are generally shallow and unconfined in nature will recharged to the ground water bodies. In polluted coastal water undoubtedly, there is a possibility of concentration of toxic elements within the food chains in the marine ecosystem. .PA

Water samples from the *periyar river* near *Eloor* region and from *vembanad* lake have been analysed for the determination Fe, Cd, Co, Ni, Cr, Cu Zn and Pb. The water sample have been collected during the time of Pre-Mansoon in the month of May and analysed for the water Quality.

Lead (Pb):

Lead has been used by man since the early years. lead usually occurs either as sulphide or oxide or Carbonate compounds of iron, Zinc, silver, Copper, Gold, Cadmium, antimany, arsenic, bismuth and other metals may he associated in various proportions.

Lead is highly toxic to humans and may originate in water form contact with the ground from the industrial wastes and water Piping itself. In the sea-water the lead content is generally 3-5 ppm. This will effect the coastal ground waters and surface water. Lead is a cumulative poison and has been known to cause a disease called 'Plumbism'. Source of lead accumulation include Cigrette smokes, automobile, IC-Engine exhausts and some foods.

The effects of lead in biological forms also quite varied. In vertebrate animals,lead is a cumulative poison which typically concentrates in bones. It is estimated that human consumes in the order of 0.33 mg. of lead daily in their diets (USPHS, 1970) Drinking water standard limits of leads is 0.05 ppm where as W.H.O. (1971) shows a maximum allowbale concentration as 0.1 mg/l. In the study area concentration of Pb ranges from 0.302 ppm 0.684 ppm in Unit I and a value of 0.316 ppm to 0.960 ppm in Unit II.

Cadmium (Cd):

Cadmium is relatively rare element, most of it occured with Zinc in Ores, soils and minerals. Cadmium is obtained as biproduct in refining Zinc and other metals. However, it is difficult to seperate Zinc and cadmium, the latter is often found in small amounts in commercially available Zinc compounds. Ever since man started to produce metals, he also started to pollute the environment with cadmium. Now a days the cadmium and cadmium compounds have been used increasingly by industries causing sharp increase in Environmental contamination. The cadmium contgent in the study area, ranges from 0.166 to 0.487 ppm in Eloor region and 0.180–0.340 ppm in the backwaters. Higher

concentrations are recorded near the ship yard and other industrial effluents.

Chromium (Cr.):

Chromium is present in the earthcrust to the extent of about 0.04% . The toxicity of chromium is distinctly dependent upon its form. The metal form Cr° is extremely common but virtually inert. Whereas the hexavalent ion Cr^{6+} is extremely toxic. Chromium is an essential trace metal for human Metabolism. In this aspect it is similar to other metals which are known to be beneficial in low concentrations and harmful at higher concentrations. Chromium compounds are very useful and are rather widely concentrated in industry.

In the study area Cr ranges from 0.90 - 1.95 ppm in Eloor region and 0.95 - 1.24 ppm in the back waters. Higher concentration is recorded from the industrial effluents near Eloor

Manganese (Mn):

Manganese is relatively common metal occurring in the earthcrust at sufficiently higher concentrations. It occurs in a number of different ores. Most of the Manganese is used in the Iron and steel industry. Manganese is highly toxic to humans but at

concentrations normally found in water and in chemical sense it is very similar to iron. Mangense, removal however, is much more difficult.

The W.H.O. (1971) recommended a maximum limit of 0.5 mg/l of manganese concentration in drinking water.

In the study area Mn. ranges from 0.492-0.695 ppm in Eloor region and 0.376 - 0.446 ppm in the back waters Maximum concentration is recorded near Eloor area.

Nickel (Ni):

Nickel found in the environment is industrial rather than natural in origin. There has been no report of wide spread damage to environment by nickel compounds.

Nickel is not considered harmful to man in harmful concentrations, No USPHS. limit for nickel in drinking water has been established. It is however, moderately toxic to aquatic organisms and can be very toxic to plant life, depending on its chemical form.

One of the most common exposure to nickel compounds is that resulting from electroplating with nickel and the most wide spread problem is the production of a dermatitis popularly known as "nickel

itch", some persons even suffer from contact with nickel plated objects with the subsequent development of nickel dermatitis.

The Nickel concentration in the study area varies from 0.033-0.43 ppm in periyar waters and a value of 0.031-0.39 ppm in backwater: The highest values are recorded near the I.R.E. Industry and cochine shipyard.

Iron (Fe):

Iron is essential element for human, animal and plant growth "Normnally iron cocentration in unpolluted water table aquifers occurs less then 0.5 mg/l due to relatively aerobic conditions prevailing there, Under Urhanised areas, which have leached terric and Manganese oxyhydroxide minerals in the sediments, reductinn of the metals to their soluble divalent form occurs. Waters that are not in contact with the atmosphere may lose their dissolved oxygen by reaction with the ferrous compounds or by the bacterial activity. Under anaerobic conditions the most abundant form of dissolved iron is the Fe^{2+} which can be present at reasonably high concentrations in equilibrium with iron compounds. the W.H.O. (1971)

Prescribed permissible limit of iron in drinking water ranges 0.3 mg/l to 1.0 mg/l.

The study area shows an Fe concentration ranging form 0.921-2.653 ppm in Periyar water and a value of 0.796-1.324 ppm in back waters. Maximum value is recorded from industrial effluents.

Zinc (Zn):

Most common Zinc compounds are not generally toxic in low to moderate concentrations nor they are particularly soluble in water. It is estimated that people consume on an average 10 to 15 mg of Zinc daily in their diets. From the stand point of water supplies, 5 ppm in the UsPHS (1970). dringking water limit (Concentration of 25 to 30 ppm have an objectionable taste and appear milky) Aquatic organisms are more sensitive than human being. Zinc concentration as low as 0.1 to 1.0 ppm have been found lethal to fish and other aquatic animals.

In the study area Zinc concentration ranges from 1.73-2.82 ppm in Eloor area and 1.55-1.94 ppm in lake waters. the maximum value recorded is in the industrial effluent collected from Eloor.

Cobalt: (CO):

There is no prescribed limit for cobalt in drinking water has been established. It is however moderately toxic to aquatic organisms.

The concentration of cobalt in the study area varies from 0.036-0.586 ppm in Eloor area and 0.042-0.460 ppm in the backwaters. Maximum value recorded is near the industries.

Copper (Cu):

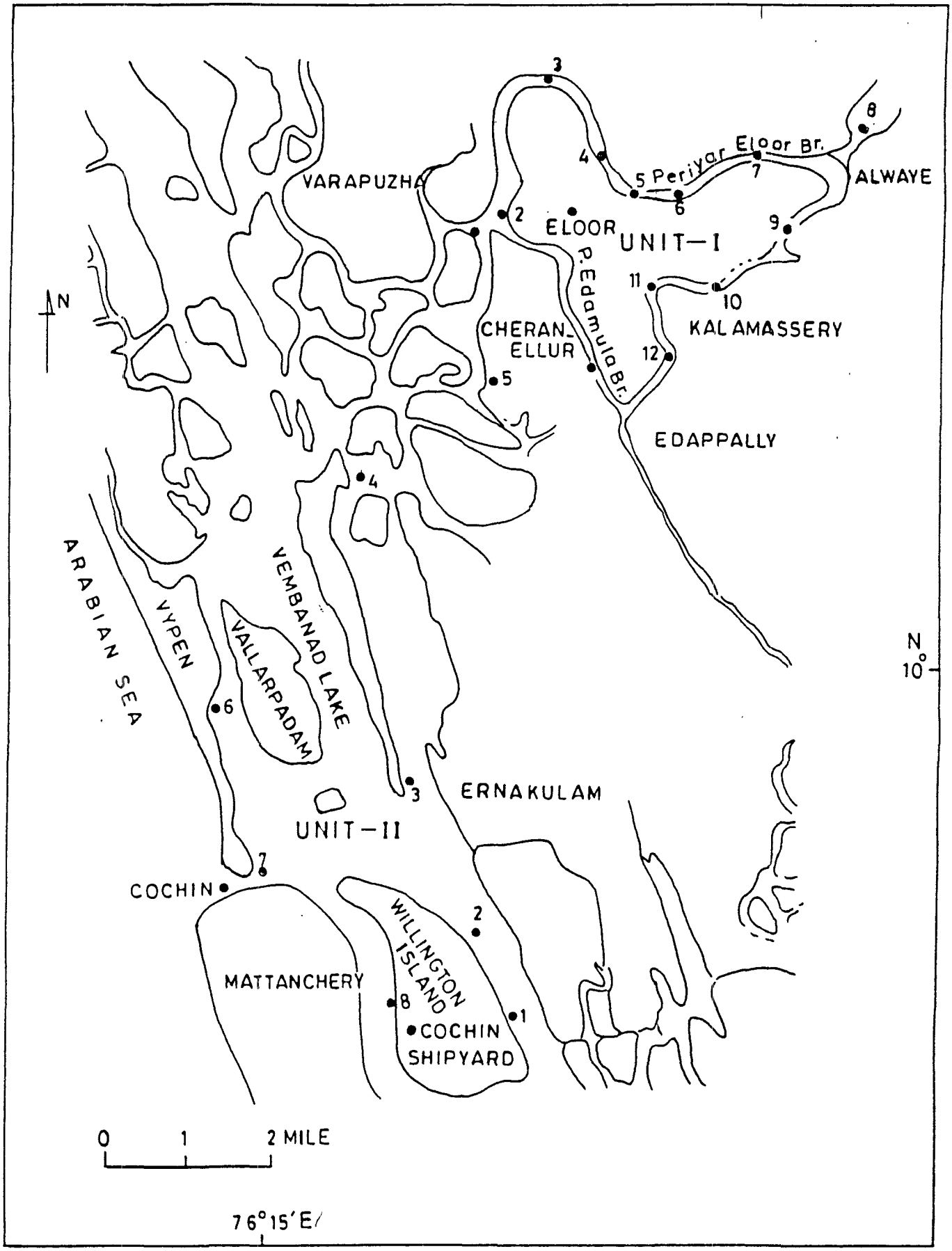
Copper is not considered harmful to man in normal concentrations. However, it is reported to have toxic effects with Zinc. The maximum permissible concentration of copper in the drinking water is 1.00 ppm.

In the study area, copper concentration ranges from 0.942-1.335 ppm in Eloor region and a value of 0.95-1.26 ppm in back water bodies.

WATER QUALITY CRITENA FOR PUBLIC WATER SUPPLY

Charecteristics	WHO ppm	USPHS ppm	ISI ppm	ICMR ppm	NTAC ppm
Arsenic	0.05	0.05	0.2	0.05	0.05
Cadmium	0.05	-	-	0.01	0.01
Copper	1.0	1.0	-	-	0.05
Chromium	0.05	0.05	0.05	-	0.05
Cyanide	0.01	0.01	-	-	-
Iron	0.3	0.3	-	-	-
Lead	0.1	0.1	0.1	0.01	0.05
Manganese	0.1	0.05	-	-	-
Mercury	-	-	-	0.001	-
Phenols	0.001	0.001	-	-	-
Selenium	0.05	0.05	-	-	-
Zinc	5.0	15	-	-	5.0
Calcium	75	-	-	-	-
Chloride	200	250	600	-	250
Flouride	1.0-1.5	1.5	-	-	-
Magnesium	50	125	-	-	-
(Mg+Na) SO_4	500	-	-	0.05	-
Nitrate	45	45	5	-	-
pH	7-8.5	-	6.9	-	6-8.5
Sulphate	2.0	250	-	-	-
Colour	5Hazen	15	-	-	-
Total Solids	500	1000	-	-	-
Turbidity	5Jackson	-	-	-	-

M-6



SAMPLING LOCATIONS IN THE STUDY AREA

RESULT OF CHEMICAL ANALYSIS OF MAJOR ELEMENTS IN PERIYAR WATER SAMPLES OF U-I
(Eloor Industial Belt) (in ppm)

SAMPLE No.	pH	Cl^-	HCO_3^-	T.H.	Ca^{++}	Mg^{++}	K^{++}	Na^{+}
1.	6.28	78.1	91.5	140.00	26.05	18.27	46.0	69.8
2.	6.18	28.4	61.0	160.00	18.03	28.01	1.3	7.2
*3.	4.50	369.2	N-D	730.00	134.26	96.24	52.0	168.0
*4.	4.80	49.7	N-D	670.00	108.20	97.45	136.0	186.0
5.	7.29	71.0	36.6	140.00	22.04	20.71	8.4	23.4
6.	6.66	56.8	42.7	130.00	22.04	18.27	22.3	58.6
7.	6.68	85.2	54.9	160.00	16.03	29.23	1.2	5.2
8.	6.82	63.4	52.3	155.00	26.55	20.64	11.2	97.0
9.	7.21	58.7	55.2	220.00	32.20	19.58	32.0	123.0
10.	6.96	46.5	48.1	190.00	28.40	20.10	18.0	110.0
11.	7.40	42.3	39.3	360.00	29.10	36.50	12.0	120.0
12.	7.60	40.8	38.6	230.00	30.06	25.60	92.0	198.0
AVERAGE	6.5316	82.508	52.02	273.0	38.825	35.889	36.03	97.18

VEMBANAD LAKE U-II

1.	8.13	12070.0	488.0	6750.0	1002.0	1035.0	112.0	598.0
2.	7.9	11085.0	470.0	6540.0	986.0	1021.0	76.0	456.0
3.	8.2	12065.0	496.0	6705.0	1116.0	1028.0	123.0	636.0
4.	8.3	12105.0	500.0	6856.0	1165.0	1046.0	36.0	700.0
5.	8.0	11050.0	465.0	6346.0	975.0	1009.0	86.0	420.0
6.	7.6	12050.0	540.0	6816.0	1175.0	1125.0	183.0	720.0
7.	7.2	12025.0	499.0	6796.0	1150.0	1100.0	164.0	672.0
8.	7.4	11090.0	480.0	5620.0	992.0	1020.0	105.0	463.0
AVERAGE	7.84	11692.5	492.25	6553.6	1070.12	1048.0	110.6	583.12

* Waste water from some Industries
T.H. Total Hardness

RESULT OF TRACE ELEMENT ANALYSIS OF PERIYAR WATER SAMPLES U-1 IN (PPM)

(ELOOR INDUSTRIAL BELT)

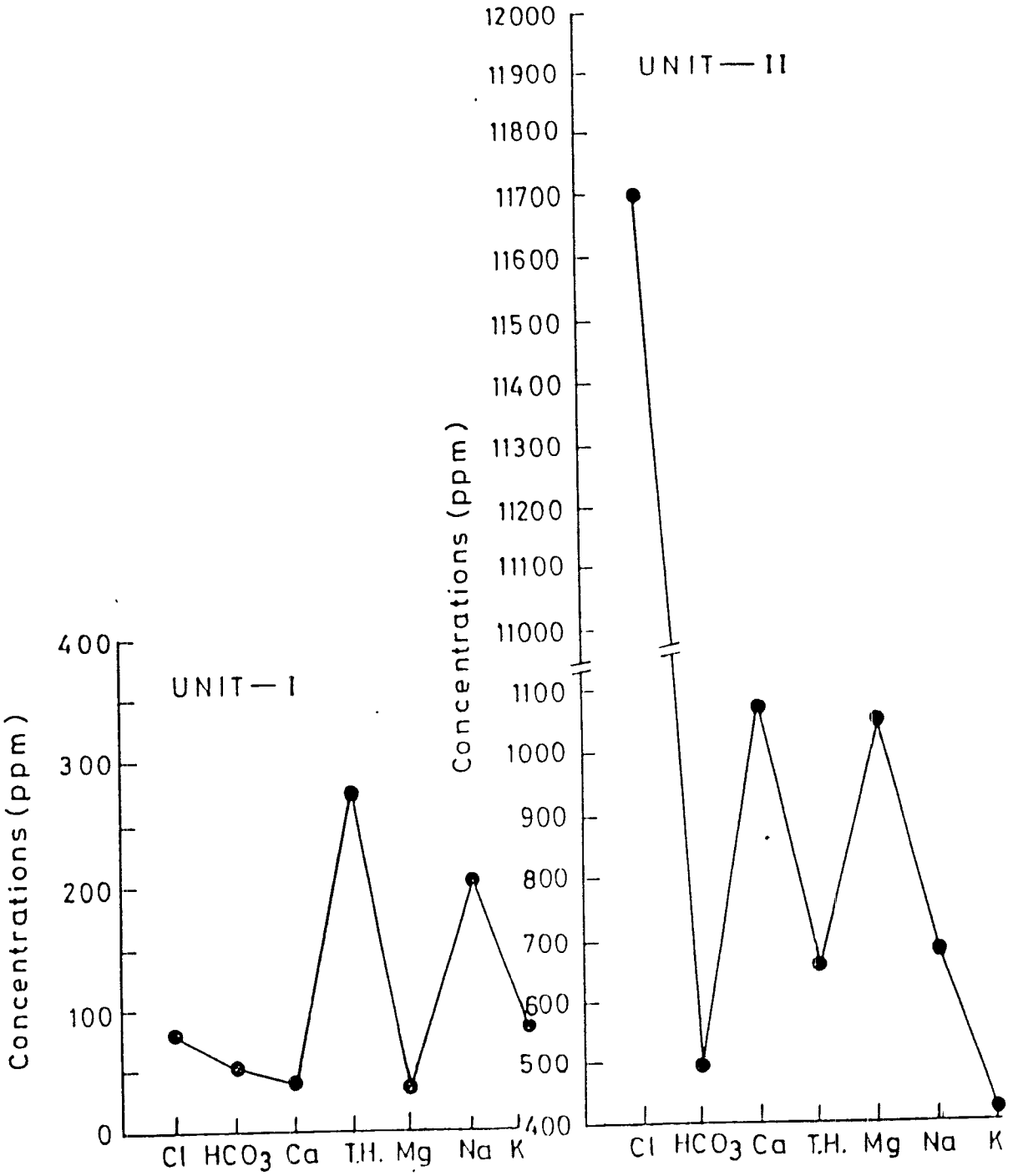
SAMPLE No.	ELEMENTS								
	Fe	Mn	Cd	Co	Ni	Pb	Zn	Cr	Cu
1.	0.921	0.572	0.269	0.052	0.048	0.302	2.53	1.41	1.216
2.	1.42	0.623	0.281	0.061	0.054	0.366	2.64	1.82	1.335
*3.	2.653	0.663	0.487	0.586	0.039	0.684	2.82	1.92	1.416
*4.	2.365	0.602	0.354	0.414	0.43	0.587	1.73	1.96	0.964
5.	1.210	0.681	0.208	0.046	0.033	0.352	2.76	1.76	0.942
6.	1.721	0.621	0.183	0.038	0.041	0.321	2.63	1.082	1.321
7.	1.146	0.585	0.216	0.046	0.036	0.381	2.68	1.23	1.624
8.	0.986	0.492	0.188	0.036	0.029	0.360	1.98	0.90	0.963
9.	1.646	0.695	0.166	0.040	0.038	0.417	2.81	1.60	1.246
10.	1.526	0.594	0.263	0.045	0.038	0.363	2.06	1.74	1.265
11.	1.496	0.604	0.283	0.048	0.046	0.366	2.15	1.68	1.185
12.	1.546	0.590	0.246	0.041	0.039	0.316	2.40	1.48	1.216
Average	1.553	0.610	0.262	0.121	0.101	0.4012	2.38	1.279	1.224

Unit II

VEMBANAD LAKE

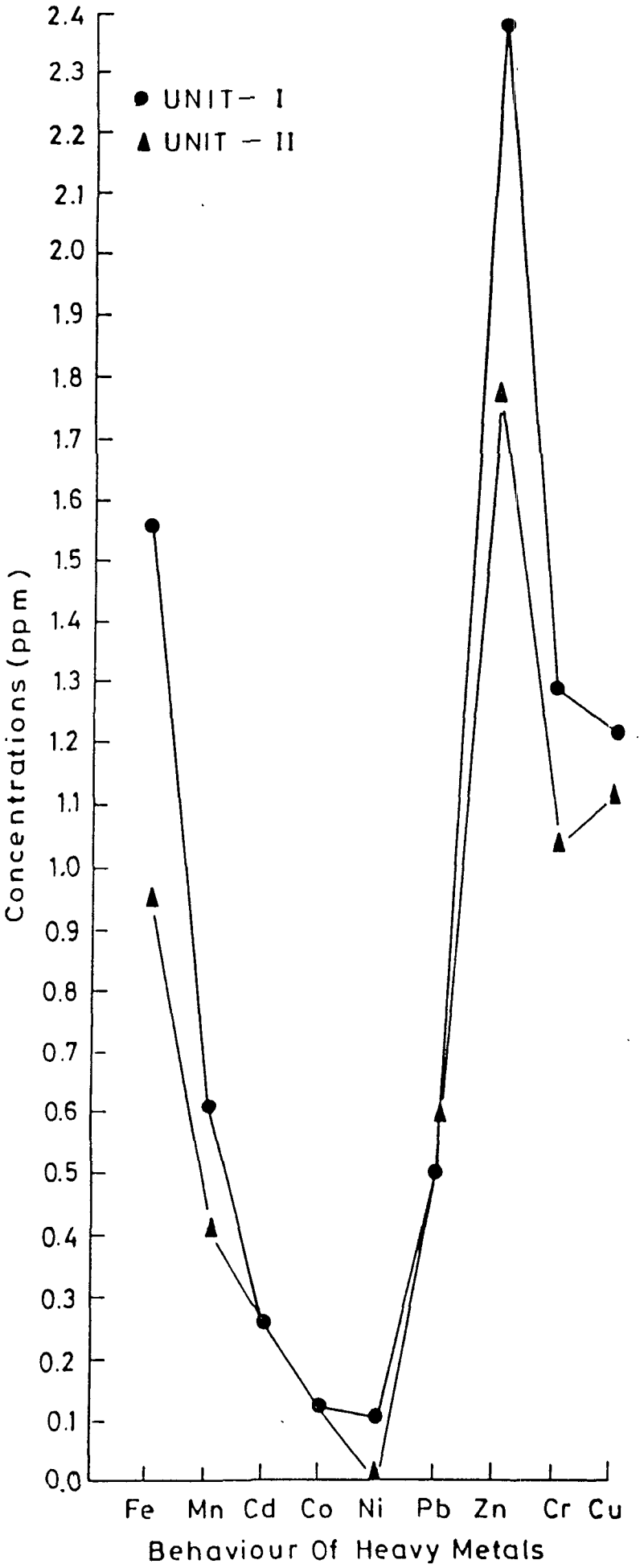
1.	0.940	0.442	0.186	0.041	0.036	0.924	1.65	0.99	0.96
2.	0.862	0.416	0.180	0.360	0.031	0.960	1.55	0.85	1.12
3.	0.796	0.376	0.210	0.042	0.035	0.384	1.80	1.01	1.98
4.	1.324	0.426	0.340	0.460	0.39	0.810	1.86	1.112	1.26
5.	0.926	0.418	0.236	0.049	0.037	0.660	1.80	0.96	1.20
6.	0.894	0.442	0.263	0.043	0.039	0.316	1.73	1.26	1.18
7.	0.823	0.392	0.260	0.042	0.035	0.350	1.82	1.01	1.95
8.	0.916	0.426	0.270	0.051	0.040	0.364	1.94	1.08	1.24
AVERAGE	0.9351	0.417	0.243	0.1385	0.0803	0.5835	1.7687	1.034	1.1112

* Waste water from some Industries:



Behaviour Of Major Elements

M-8


UNIT- I
UNIT - II
Concentrations (ppm)
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Fe Mn Cd Co Ni Pb Zn Cr Cu
Behaviour Of Heavy Metals

CHAPTER - VII

WATER POLLUTION DUE TO EXISTING INDUSTRIES IN THE STUDY AREA

INTRODUCTION:

The Coastal sedimentary basin of Kerala extends along the West Coast of India for a length of about 600 K.M. The maximum width of this large coastal basin is about 25.K.M. near Alleppey. The deepest portion of the basin lies between Chellanam and 'Chavara', The major rivers like Periyar, Pamba Muvatupuzba , Minachil, Rhavata Puzha. etc. cut a cross the basin form east to west, and from the main channels of drainage . Besides this the alluvial plain is extensively invaded by backwater channels, tidal lagoon and brakish water lakes. The coastal sedimentary basin is under tropical climate and average annual rainfall varies form 170 cm in the southern parts to 365 c.m. in the north. The entire belt is thickly populated. Paddy and coconut are the most important agricultural products in the coastal Plain.

The study area,cochin is a part of this large coastal sedimentary basin . It receives an average annual rainfall of 3050 M.M. The area is drained by

Periyar river in the north and Pampa river in the south which later join the backwaters and finally reaches to Arabian sea. The study area falls in Eranakulam district, South to Alwaye and about 5 K.M. north of Ernakulam city. The study area falls in the Topo sheet number 58- c/6 and is located at a latitude of 9°48' and 9°58'N and longitudes of 76°14' and 76°48'E.

Water Pollution Status of the Area:

Industrialization of any country unavoidally creates environmental Pollution Problems. We are now gradually heading towards severe environmental damage; i.e., Deforestation, water Pollution, Air Pollution, wide spread land degradation, mushrooming growth of slums and Population explosion. Water pollution normally manifests itself with Poisoning of aquatic life resulting in the reduction of the quantity and quality of fish and other aquatic life. Heavy industrialization coupled with open sewage in the major rivers in most part of the civilized world has resulted in degradation of water quality of these surface sources.

Environmental Pollution has become a grim of reality in the last part of the twentieth century. No where are the signs of Pollution clearly visible as in

the aquatic environment. It is common practise to discharge domestic sewage and industrial effluents in rivers, estuaries and other near shore (marine) environments.

Amongst the Pollutants, the heavy metals received much attention owing to it's profuse occurance in industrial effluents and domestic sewages. Most of the metal ions are essential to sustain organic life, however, when their concentration exceeds certain optimum levels, they become toxic and threat to the animal life. During the last three decades or so intensive researches are being carried out in this field on a global and regional basis to estimate the quality and quantity of heavy metals in sediments and water to know the impact on the ecosystem. Hence the assessment is made from waters of periyar river, vembanad estuary and adjascent environments of the Arabian sea.

In the study area there are many large and small scale industries located in Eloor (Udyogmandal) and Ambalamukal areas which directly discharge their effluents into the Periyar, Pamba, muvathu Puzha rivers and to the Back waters. The industrial belt extend to nearly 16 K.M. from Vara Puzha to Alwaye (Aluva). Most

of the Industries are located on the bank of the river Periyar and they are continuously discharging their waste water into the river. Large scale industries are mostly of Fertilizers and chemical type, but small scale include coconut retting and Prawn industries etc. The industrial waste water which is beyond the reach of the river also discharge their effluents in ditches as well as in drains located near these industries. In all these cases the industrial effluents are discharged without giving any Proper treatments.

The periyar river is the recipient of a wide variety of pollutants from various industries located on its banks (paul and pilla, 1978). The heavy metal estimation reveals the localized concentration of certain heavy metal, especially cd, Co, Zn, Cr and Pb in the vicinity of Eloor industrial belt as well as adjascent regions of north vembanad estuary.Such an isolated enrichment of the above mentioned heavy metals were also reported earlier by Paul and Pillai (1983). A cursory analysis of literature shows that about 70% of the state's chemical/ Fertilizer/Smelting industries are located in and around Eloor especially on the banks of river Periyar. It is estimated that more than 1 lakh kilo litres of effluents are added to

a narrow distributory of Periyer river "The Eloor Branch", The uneven flow patern due to meandering and branching does not allow the free flow of effluent rich sediments to the estuary or sea. This may be the reason for the localized accumulation of Pollutants. All these Pollutants in sediments and water not only affect the life of animals and Plants of this ecosystem but also the huyman beings living in and around cochin area.

The Pamba, one of the holy rivers of south India flowing at the foothills of Sabarimala, is being used more than 25 lakhs of devotees every year. The intensity of Anthropogenic activity has considerably altered the natural phase of the Pamba river. The influx of detergent waste products, feacal materals, and leakage of oils/grease from automobiles have not only changed the physical properties of the water and sediments/ of the pamba river but also considerably enhanced the heavy metal abundance.

The bio-accumulation of heavy metals and their effects have been studied from Cochin area by several investigators (Paul & Pillai, 1983, Proceeding of National seminar on Massel watch, 1986, and other). It is found that trace metal contents were higher in the organisms from industrial regions than the other areas.

The enrichment of metals both in organisms as well as in sediments and waters reflect the effect of industrialization.

The major sources of industrial pollution in the study araa in general could be grouped as follows.

1- Fertilizers plant
2- Insecticides plant
3- Aluminium Industries
4- Chemical Industries
5- Distillaries
6- Oil Refinary
7- Ship yard
8- Leather Factories

Survey of Industrial Units in the Area:

A survey of the industrial unis and their role in water pollution revealed that there are several industries which are producing liquid wastes and are discharging into the river and lands nearby.

Following are the lists of heavy industries in various Units.

1- Fertilizers And Chemicals Travancore Ltd., Udyogamandal (FACT).

2- Hindustan Insecticides Ltd; Udyogamandal.

3- Indian Aluminium Company, Udyogamandal.

4- Indian Rare Earths Ltd; Udyogamandal.

5- Travancore Cochin Chemicals Ltd.; Udyogamadal

6- Cominco Binani Zinc Ltd.; Binanipuram.

7- Kerala Acids and Chemicals Ltd; Binani Puram.

8- Periyar Chemicals Ltd.; Binanipuram.

9- Thotakkattu Distillaries; Binani puram.

10- United catalysts India Ltd.; Binani puram.

11- Alliance Leathers Pvt.Ltd, BinaniPuram

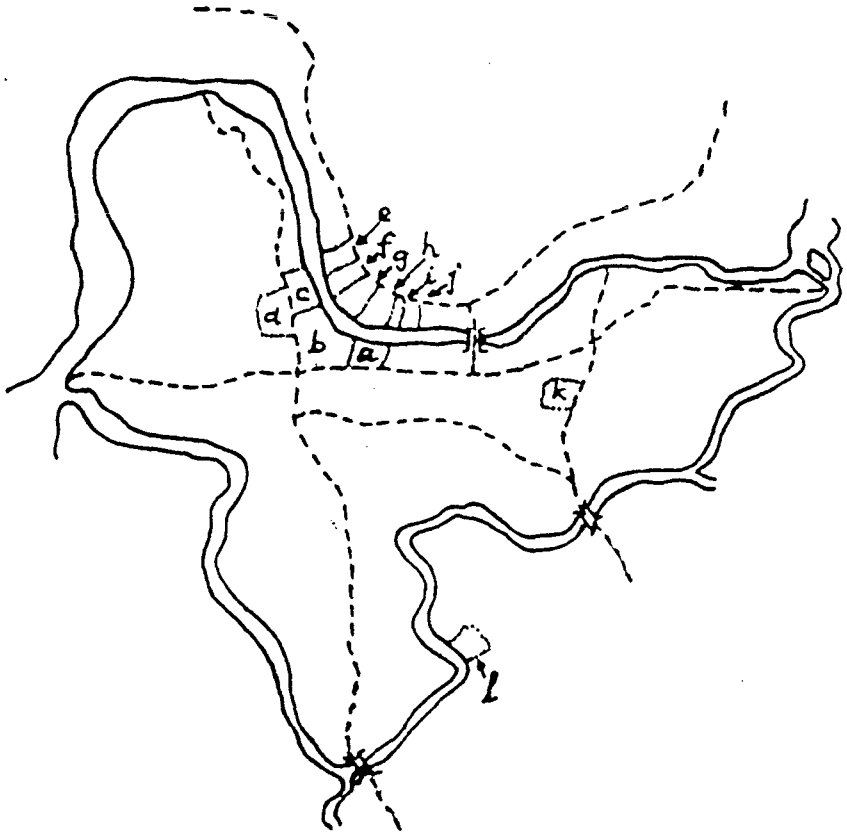
12- Travancore Chemicals And Manufacturing Company- Kalamassery

13- Travancore Rayons; Perumba Voor.

14- Cochin shipyard. Ltd, Cochin.

15- Cochin Oil Refinaries Ltd.; Cochin.

The following are the list of Industries their Products and Effluent Details collected from "Kerala State. Pollution control Board" Regional Office, Cochin 1990.



LEGEND

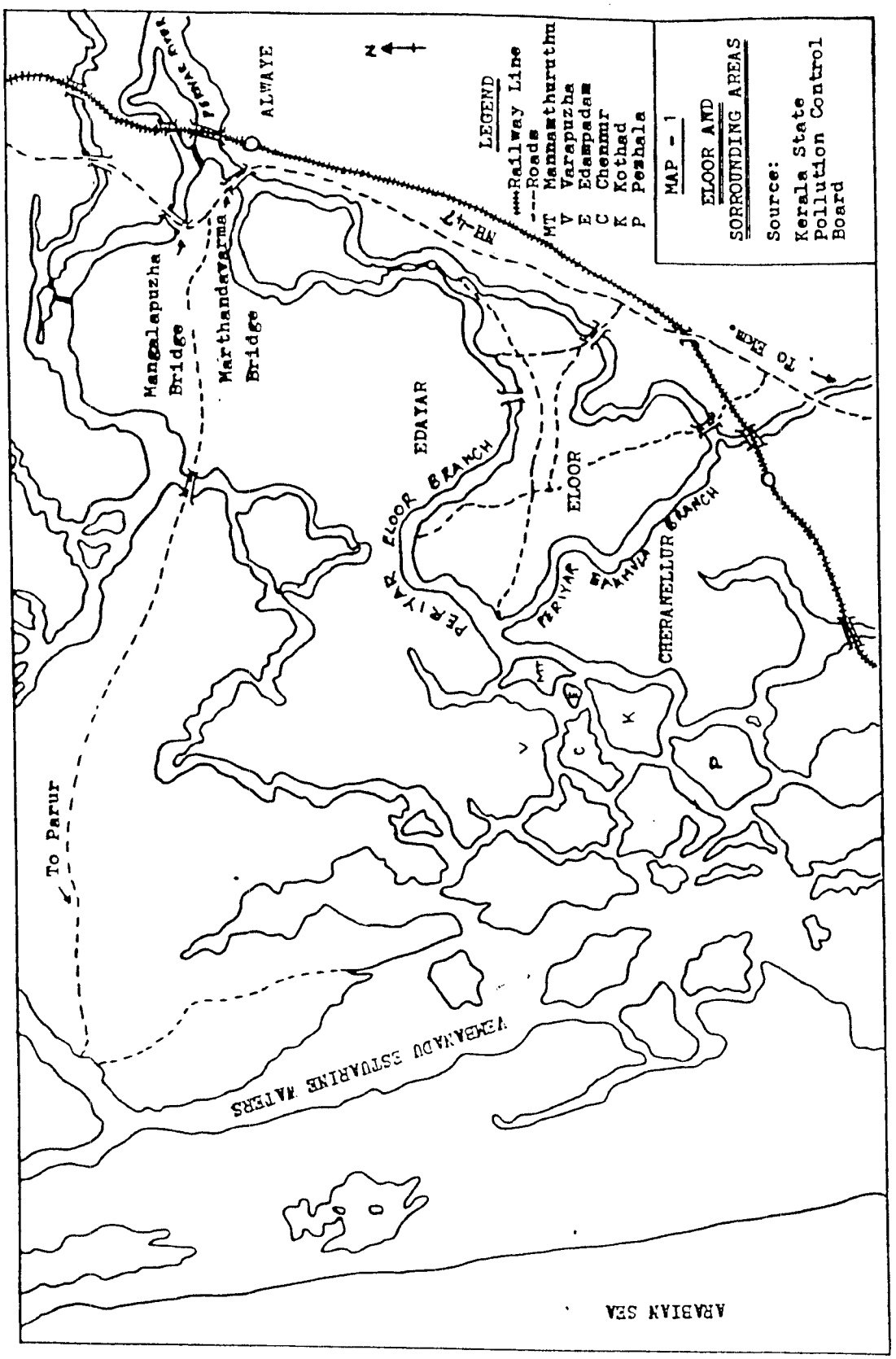
a. Travancore Cochin Chemicals Ltd.
b. FACT Ltd.
c. Indian Rare Earths Ltd.
d. Hindustan Insecticides Ltd.
e. Cominco Binani Zinc Ltd.
f. United Catalysts India Ltd.
g. Periyar Chemicals Ltd.
h. Kerala Acids and Chemicals Ltd.
i. Alliance Leathers Pvt. Ltd.
j. Thottakattu Distillaries.
k. Indian Aluminium Co. Ltd.
l. Travancore Chemicals Manufacturing Co. Ltd.

MAP - 2

INDUSTRIES IN

ELOOR - EDAYAR

Scale: 1;50,000


MAP - 1
ELOOR AND
SORROUNDING AREAS
Source:
Kerala State
Pollution Control
Board
LEGEND
Railway Line
Roads
MT Manmarthuruthu
V Varapuzha
E Edampadam
C Chemmr
K Kothad
P Peshala
N
ALWAYE
Periyar River
Mangalapuzha Bridge
Marthandavarma Bridge
NH-47
To Ekm.
EDAYAR
PERIYAR ELOOR BRANCH
ELOOR
PERIYAR ELOOR BRANCH
CHERANELLUR BRANCH
To Parur
VEMBANAD ESTUARINE WATERS
ARABIAN SEA

LIST OF INDUSTRIES AND EFFLUENT DETAILS

NAME OF INDUSTRY	RAW MATERIALS (t.p.d)	PRODUCT CHATACTERISTICS (t.p.d)	EFFLUENT QUANTITY (KLD)	WATER CONSUMPTION (KLD) AND SOURCE
1	2	3	4	5
1. Fertilizers And Chemicals Travancore Ltd., Udyogamandal.	Sulfur - 200 Rock Phosphate - 273 Naptha - 323 Hydrochloric acid - 20	Ammonia - 340 Amm. Sulfur - 600 Sulfuric Acid - 740 Amm. Phosphate (16:20) - 300 Amm. Phosphate (20:20) - 150 Phosphoric Acid - 100 Super Phosphate - 150 Amm. Chloride - 75 Liquid SO_2 - 10 Cryolite - 3	77000	107148 Periyar
2. Cominco Binani Zinc Ltd., Binanipuram.	Zinc Concentrate -110	Zinc - 40 Sulfuric Acid - 65 Cadmium - 0.061	8300	8645 Periyar
3. Hindustan Insecticides Ltd., Udyogamandal.	Benzene - 6.4 Alcohol - 1.5 Chlorine - 15 Oleum - 7.5	DDT Tech. - 4 BHC - 10 DDT (50%) - 10 BHC (50%) - 10	620	1260 FACT

Continued..

1	2	3	4	5
4. Indian Aluminium Company, Udyogamandal.	Alumina - 105 Petroleum Cake - 20 Pitch - 8 Aluminium Chloride - 2.5 Cryolite - 1	Aluminium ingots - 14 Aluminium extrusions - 14 Aluminium wire rod - 27	7090	7364 FACT
5. Indian Rare Earths Ltd., Udyogamandal.	Monazite Sand - 12 Caustic Soda - 7.2 HCl - Chlorine - Nitric Acid -	Trisodium phosphate - 18 Rare Earth chlorides - 14 Rare Earth Oxide -	2300	3560 FACT
6. Kerala Acids And Chemicals Ltd., Binanipuram.	Caustic Soda - 4.5 Sulfuric Acid - 5.2 Mixed Gas containing CO - 10000 Nm^3/day	Formic Acid - 45 Sodium Sulfate - 7	86	2122 FACT
7. Periyar Chemicals Ltd., Binanipuram.	Caustic Soda - 3.3 30% CO - 320000 Nm^3 Sulfuric Acid - 4.5	Formic Acid - 3.25 Sodium Sulfate - 6	22	112 FACT
8. Thottakkattu Distillaries, Binanipuram.	Molasses and yeast	Industrial Alcohol Rectified Spirit	75	
9. Travancore Cochin Chemicals Ltd., Udyogamandal.	Common Salt - 350 Sulfur - 1.89 Zinc Dust - 3.5 Sulfur Dioxide - 6.37	Caustic Soda - 175 Sodium Sulfate - 7 Sodium Hydrosulfate 7 Liquid Chlorine and HCl - 155 Bleach Liquor 100 L/day		

Continued..

1	2		3		4	5
10. Travancore Chemicals And Manufacturing Co., Kalamassery.	Copper Scrap Bauxite Sulfuric Acid HCl Caustic Soda Sodium Chloride	- 4 - 3.33 - 6 - 2 - 1 - 3.5	Copper Oxychloride Copper Sulfate Sodium Aluminate Aluminium Sulfate Sodium Chlorate Potassium Chlorate	- 3 - 10 - 2.5 - 6.7 - 2 - 5.2	325	455 Periyar
11. Travancore Rayons, Perumbavoor.	Cotton Linter Sulfur Caustic Soda Sodium Sulfide Zinc Chlorine Wood Pulp	- 20 - 21 - 21.3 - 1.05 - 0.16 - 0.17 - 9.87	Cotton Linter Pulp Sulfuric Acid Cadmium di Sulfide Cellulosic Filament yarn Cellulose Film	- 24 - 61 - 11 - 15 - 13.3	46000	46000 Periyar
12. United Catalysts India Ltd., Binanipuram.	Copper Zinc Sulfuric Acid Caustic Soda Ammonia Alumina Graphite	- 0.25 - 0.28 - 1.48 - 1.15 - 6.56 - 0.05 - 0.04	Catalysts for Fertilizers and Petro Chemical Industries. (Reformer, Methanator, HT Shift, LT Shift, Acetone and Zinc Oxide Catalysts).		537	601 FACT
13. Alliance Leathers Pvt. Ltd., Binanipuram.	Lime Sodium Sulfate Amm. Sulfate Chrome Powder Sodium Bicarbonate Sodium Formate etc.	- 24 - 9 - 0.31 - 21.1 11.55 - 5.25	Wet Blue Cow Hides			

SOURCE: Kerala State Pollution Control Board. Regional Office, Cochin. 1990.

STATEMENT SHOWING THE CHARACTERISTICS OF THE WASTES DISCHARGED FROM VARIOUS INDUSTRIES LOCATED ON THE BANK OF THE PERIYAR

NAME OF INDUSTRY	CONSTITUENTS	RAW EFFLUENT	PRESENT QUALITY	EFFLUENT STANDARDS	REMARKS
1	2	3	4	5	6
1. Fertilizers And Chemicals Travancore Ltd., Udyogamandal.	pH	11	10	5.5 to 9.0	
	SS	180	14	100	
	DS	3600	707	2100	Neutralization,
	Amm. Nitrogen	350	86	50	
	Free Ammonia	100	40	5	Clarifier,
	Fluorides	108	58	2	Carbon Slurry - Filter,
	Diss. Phosphates	210	Trace	5	
	Chlorides	600	Trace	1000	
	Sulfates	1400	160	1000	NH_3 Stripping
	BOD	20	Trace	30	
	COD	200	20	250	
2. Cominco Binani Zinc Ltd., Binanipuram.	pH	3.75	700	5.5 to 9.0	
	BOD	150	Trace	30	
	COD	250	-	250	
	SS	500	10	100	Neutralization,
	TDS	4200	220	2100	
	Fluorides	30	0.2	2	Precipitation,
	Sulfates	2000	25	1000	Settling.
	Zinc	15	0.5	5	
	Cadmium	2	ND	2	

Continued..

1	2	3	4	5	6
3. Hindustan Insecticides Ltd., Udyogamandal.	BHC) Insecticides	13	0.015		
	DDT)	2	0.002	Absent	
	pH		2.8	5.5 to 9.0	Equalization,
	BOD		5	30	
	COD		52	250	Neutralization,
	TDS (inorganic)	10000	2000	2100	Settling in
	TSS	250	20	100	Clarifier Lagoon.
	Chlorides	1000	1000	1000	
	Diss. Phosphates		-	5	
	Phenolic Compounds		ND	1	
	Sulfates	1000	1000	1000	
	Sulfides	-	ND	2	
	Oil & Grease	9.5	-	10	
4. Indian Aluminium Company. Udyogamandal.	pH		6.5	5.5 to 9.0	
	TSS		40	100	
	TDS (inorganic)		1828	2100	No Treatment.
	Sulfates		5	1000	
	Fluorides		2.2	2	Effluent
	Oil & Grease		8.8	10	comprises of
	Free Ammonia		ND	5	canteen effluent
	Amm. Nitrogen		3.5	50	and cooling
	Zinc		ND	5	water.
	BOD		5.2	30	
5. Kerala Acids And Chemicals Ltd., Binanipuram.	pH	2.05	4		
	BOD	150	130	5.5 to 9.0	The Company is not
	TSS	200	8	30	discharging directly
	TDS	10332	7400	100	into river, but
	Oil & Grease	8	-	2100	into land. Only
	Sulfates	5000	3900	10	settling tank
				1000	provided. Additional
					treatment is
					required.

continued...

1	2	3	4	5	6
6. Indian Rare Earths Ltd., Udyogamandal.	pH		6.6	5.5 to 9.0	The Materials stored in the Silos have the following composition -
	TSS		14	100	
	TDS		448	2100	
	COD		8	250	
	Fluorides		2.8	2	
	Amm. Nitrogen		10	50	Thorium Hydroxide - 40%
	Diss. Phosphates		9.8	5	Uranium Oxide - 1.5%
	Chlorides		200	1000	Rare Earth Hydroxide - 3.5%
	Lead		0.06	0.1	Water - 55%
	Zinc		-	5	
	Sulfides		ND	2	Neutralization, Chemical Treatment, Clarifier, Final pH correction.
	Sulfates		70	1000	
	Alpha Emitters		4.2	3.7	
	Beta Emitters		8.9	37	
7. Periyar Chemicals Ltd., Binanipuram.	pH	1.2	7.6	5.5 to 9.0	Neutralization, cum settling facility provided with surface aeration.
	BOD	250	172	30	
	TSS	250	45	100	
	TDS	7300	4612	2100	
	Sulfates	4500	1375	1000	
	Oil & Grease	9.5	ND	10	
	COD		400	250	
8. Thottekkattu Distilleries, Binanipuram.	pH	3.6	4.84	5.5 to 9.0	Only Settling facility.
	BOD	27400	1580	30	
	COD	38200	2144	250	Treatment Schemes not Provided.
	TSS	385	611	100	
	TDS	9000	3164	2100	
	Sulfates	250	Trace	1000	
	Amm. Nitrogen	15	1.64	50	
	Acidity	500	-		

Continued...

1	2	3	4	5	6
9. Travancore Cochin Chemicals Ltd., Udyogamandal.	pH	12.5	8.6 to 10.2	5.5 to 9.0	
	TSS	152	28	100	Chemical treatment for removal and recovery of Mercury.
	Res. Chlorine	100	0 to 4.7	1	
	Sulfide	-	ND	2	
	Mercury	30	0.005	0.01	
	Oil & Grease	-	ND	10	Chlorine scrubbing system, Neutralizing, Settling Ponds.
10. Travancore Chemicals And Manufacturing Co. Ltd., Kalamasserry.	pH	7.2	7.5	5.5 to 9.0	
	BOD	80	60	30	Canteen effluents discharged directly into river.
	COD	114	88	250	
	TSS	206	258	100	
	TDS	2782	6200	2100	
	Fluorides	1.14	0.32	2	
	Chromium (VI)	2	ND	0.1	Neutralization cum settling.
	Zinc	-	3	5	
	Copper	8.2	1.15	3	
	Oil & Grease	6	ND	10	
	Lead		ND	0.1	
11. Travancore Rayons, Perumbavoor.	pH	2.8	6.6	5.5 to 9.0	
	TSS		91	100	Neutralization,
	BOD		52	30	
	COD		210	250	Flash Mixer,
	Oil & Grease		8	10	
	Zinc		-	5	Clarifier and
	TDS		900	2100	
	Sulfides		1.7	2	Settling Ponds.
	Amm. Nitrogen		-	50	

Continued...

1	2	3	4	5	6
12. United Catalysts India Ltd., Binanipuram.	pH	2.6	12	5.5 to 9.0	
	TDS	10080	8080	2100	Sand Filters and Neutralization
	Amm. Nitrogen	50	5	50	
	Chromium (VI)	1	0.08	0.1	
	Zinc	10.8	3	5	
	Sulfate	5000	1700	1000	
	% Sodium	9500	-	60	
	Free Ammonia	15	5	5	
13. Ammonium Sulfate Caprolactum, Udyogamandal.	pH	-			
	BOD	151			
	COD	1260			The Project is yet to be Commissioned.
	TSS	100.8			
	Oil & Grease	25.2			
	Total Ammonia	304			
	Free Ammonia	25			
14. Alliance Leathers Pvt. Ltd., Binanipuram.	pH	7.6		5.5 to 9.0	Started Production very recently.
	TSS	3000		100	
	TDS	4500		2100	
	BOD	2064		30	
	COD	5272		250	
	Chlorides	4500		1000	
	Oil & Grease	100		10	

Note: All units except for pH are in $mg.L^{-1}$

SOURCE: Kerala State Pollution Control Board, Regional office, Cochin. 1990.

SUMMARY AND CONCLUSION

The consequences of massive water and soil pollution in relation to the health of the nation are of great concern because two-third of all illness in India is reported to be related to the water-borne diseases through metal intoxication such as typhoid, jaundice, cholera, diarrhoea, dysentery, cancer, ulcers, abdominal, colic and respiratory illness. Potential toxic metals, to a large extent, are dispersed into the environment through the industrial effluents, agricultural wastes, community waste, organic waste, refuse burning, automobiles and power generator plants. Presence of trace metals in environmennt is considered unique because it is difficult to remove completely these metals from the environment which has been contaminated. Rapidly increasing use of a wide variety of metals in industries and our daily life, problems arising from toxic metal and pollution of environment have assumed serious dimensions.

The study area covers south-western part of Kerala which is bounded by three important rivers namely, Periyar in the north, Pampa in the south and Muvattu Puzha in the east. The study area falls in Ernakulam

district. The area is agriculturally very rich and is thickly populated. It is one of the fast developing industrial regions of India.

A systemtic study of the chemical nature of surface water bodies from those areas from Eloor to cochin harbour has been made with a view to find out the extent of Pollution of various cations and anions (Cl, Ca, Mg, HCO_3 etc.) in these water bodies. Detection and determination of trace elements namely Fe, Zn,Cr, Pb, Mn, Co, Cd, Ni, and Cu in these water bodies has also been made. Some industrial effluents are also analysed for the major and trace element concentration. the results have been interpreted on the basis of demography and Industrialization.

The trace metal contents, in the water samples from Unit I (Eloor Industrial belt) ranged as follows. Fe 0.921 to 2.653 ppm, Mn 0.492 to 0.695 ppm, Cd 0.166 to 0.487 ppm, CO 0.036 to 0.586 ppm, in the surface water sampels. On the other hand, the concentration of other trace metals ranged as Ni 0.029 to 0.43 ppm, Pb 0.302 to 0.684 ppm, Zn 1.73 to 2.82 ppm, Cr 0.90 to 1.96 ppm and Cu ranges from 0.942 to 1.624 ppm.

While in Unit II the metal content ranged from Fe 0.796 to 1.324 ppm, Mn 0.376 to 0.0442 ppm, Cd 0.180 to 0.340 ppm, Cn 0.042 to 0.460 ppm in the surface water samples. The concentration of other elemens ranged as follows Ni 0.031 to 0.39 ppm, Pb 0.316 to 0.960 ppm, Zn 1.55 to 1.94 ppm, Cr 0.85 to 1.26 ppm and Cu ranges from 0.95 to 1.26 ppm in the surface water bodies.

While comparing the Fe content with WHO (1971) standards, the concentrations in both the units are well within the permissible limits. The Mn content 0.0695 and 0.442 in surface water of unit I and II respectively exceeds the WHO permissible limits.

It is alarming taht, the Cd and Pb concentrations in both the units exceeds the prescribed limits of WHO (1971). The concentration of Cr and Cu are also exceeds the permissible limits whenre as concentration of Zn is well within the prescribed limit.

The higher concentrations of Zn ,Pb, Cd, Mn, Cu and Cr in water samples of unit I in comparison to Unit II may be due to the presence of I industries like chemicals, fertilizers and rare Earths in this region which directly discharge their effluents into the river. The highest concentration of trace metals in the surface water samples of Unit I reflects the

highest degree of pollution along the stretch. The area that falls under unit I is highly industrialized and contain numerous industries ranging from leather, Distilaries, chemicals, Insecticides, Rare Earths, prawn processing factories and Fertilizers. Periyar river directly or indirectly receives waste waters discharged from various industries.

In unit II (Cochin harbour and surrounding area) there are some industries like cochin oil Refinnary, Cochin shipyard etc. Which directly dischange their wastes into the vembanad lake and obviously these waste effluents are poor in trace metal content but rich in organic pollutants.

The lowest and highest cocentration of the trace metals in the water samples from both the units have been explained by considering the location of the Collection sites, proximity of the waste discharge sites, nature of the waste discharges, types and size of the industry and nature of the soil. It appears that the concentration of trace metals are higher in water samples collected from sites that are located in the domains of industrialization or other man-made activities.

The highest concentration of major elements in surface water samples have been found in Unit II. The major elements concentration in Unit I is well within the limits where as concentration of unit II samples are higher than the permissible limis suggested by various organisations for potable and irrigational purposes.

Cadmimum is found in signiificant concentration from the effluents released from "Cominco Binani Zinc Industry. The exposure of cadmium results in respiratory disorders, kidney damage, liver disfunction, anaemic and hypertension. The surface water of unit I and II are contaminated with lead (Pb) which is discharged from the units employed in manufacturing of chemicals and Rare Earths. Lead particulates are also present in the fumes of automobiles Pb poisoning causes diseases such as anaemia, damage to central nervous system and mental deterioration. Chromium is found in significant amount from effluents, relased from industial units employed in manufacturing catalysts, fertilizers and chemicals. Chromium and Nickel poisoning cause diseases like production of dermatities, to the workers of that unit.

Respiratory illness, ASthma, Neurological disorder are the common symptoms associated with Mn uptake.

No single treatment technique has been found effective for the removal of all potentially toxic metals from the water and wastes to an acceptable degree. For the majority of wastes, the solution lies in treatment by physical, chemical and biological processes which will remove suspended, colloidal and dissolved solids. Sedimentation, filtration and coagulation will remove upto 50% of the organic material. The treatment method employed for the removal of metals from wastes discharge includes precipitation, ion-exchange, solvent extraction, evaporation, reverse-osmosis, electrodialysis and adsorption (by clays, activated carbon etc.). Ion exchange reverse osmosis, electrodialysis, distillation and floatation process can remove Cd from waste water. In the industrial effluents chromium can be removed by reduction and precipitation reactions or by ion-exchange in which chromate salt can be recovered and the de-ionised water can be used. Electrodialysis, ion-exchange and reverse osmosis can be employed for the removal of lead. Catalytic air oxidation at an alkaline

pH is usually the most economical method for the treatment of Mn.

The water pollution in the study area is mainly due to the indiscriminate disposal of industrial wastes, both on land and other surface water channels (rivers, municipal sewers etc.) From this investigation it is found that the industrially influenced regions of Periyar river and North Vembanad estuary show comparatively high content of pollutants which includes high concentrations of Cd, Co, Zn, Cr, Mn Pb and Cu. Continous monitoring and stringent remedial measures should be implimented to reduce the metal content in the industrial effluents to avoid further environmental impairements of this regions. Adoption of better industrial and agricultural practices will be necessary to prevent more toxic. Practises will be necessary to prevent more toxic wastes from being discharged into the river. The disposal of industrial wastes on land should not be allowed in Populated areas and collection of pretreated effluents from all the industries into a single tank and its pumping far into the sea, through an undergound conduit is probably a permanent solution for the present problem. Another suggestion is to increase the flow rate through Eloor branch of Periyar river by construction of guide walls in the periyar at

appropriate places to divert sufficient amount of the water to this branch. This will enable the flow to carry the pollutants and waste materials to the sea, Modern public health protection is provided by highly refined and well controlled plants both for the purification of community water supply and treatment of the waste water.

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